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LIFE AND DEATH AT WORK

Industrial Accidents as a Case of Socially Produced Error

TOM DWYER

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Life and Death at Work

Industrial Accidents as a Case of Socially Produced Error

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To Cassia

Preface

This book benefited from the financial support of a French Government scholarship between 1976 and 1978. It sponsored a doctoral thesis in which initial theoretical, empirical, and historical reflections on accidents were developed and written while I was a student at the Ecole des Hautes Etudes en Sciences Sociales in Paris. The New Zealand Department of Labour funded a study on industrial accidents and night work during 1979–80. In 1982–83, the award of a postdoctoral fellowship by the University of Canterbury (New Zealand) permitted a first version of this book to be finished. In the summer of 1986–87 the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) and the Laboratoire d'Ergonomie et de Neurophysiologie du Travail of the Centre National des Arts et Métiers joined forces to fund a stay in Paris where the second draft of this book was presented in a special doctoral seminar series. The third draft was completed during a 1988 research leave granted by the Conjunto de Ciência Política of the Universidade Estadual de Campinas (UNICAMP). On a further research leave from the same unit, and thanks to a postdoctoral fellowship from the Brazilian Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), final redrafting was carried out between August and October 1990 when I was a visiting fellow in the Science, Technology, and Society Program at Cornell University. I am deeply grateful to these institutions for their generosity.

To carry out research such as this, much more than financial support is necessary. Various trade unions affiliated with the New Zealand Federation of Labour, as well as the New Zealand Employers' Federation and the New Zealand Manufacturers' Association, all opened doors to facilitate access to research sites. In France a similar role was played by the Parisian section of the Organisme Professionnel de Prévention du

Bâtiment et des Travaux Publics (OPPBTP) and the construction and factory inspectors' sections of the Confédération Française du Travail (CFDT).

Once companies had agreed to research being conducted, and once introduced into workplaces, I observed work, examined company statistics and records, and conducted many semistructured interviews. Workers, unionists, foremen, managers, medical specialists, ergonomists, and others spared their time to talk with me. Their judgments, reflections, and perceptions provide crucial raw material for this book. However, another side of my contact with many of these people left a profound impression: their harsh judgments of, indignation at, and emotional reactions to their exposure to risks that others, frequently more privileged, did not experience. A strong impression was also left by others, especially those who in positions of responsibility suffered genuine moral dilemmas as they managed work in ways that they knew would lead to accidents. The efforts of both parties to cover up and sublimate the question and their seemingly paradoxical eagerness to talk about it provided a constant stimulus to push forward with research and reflection. Thus, the information these people provided, the warmth with which they received me, and the manner in which they opened up their hearts were important ingredients of this research process. Many safety professionals and government employees outside of the research sites have also generously given of their time and wisdom in trying to help me better understand their worlds.

Over the years a number of people, milieus, and events have been crucial to the development of my intellectual life and through this have played a role in shaping this book. My earliest research into accidents reflected the combined input of three teachers at Victoria University (New Zealand): Stephen Mugford, my first sociology teacher; Jan Pouwer, my first theory teacher; and Allan Levett, my first teacher of sociological theory.

This book is made up of six chapters, each of which was written at a different point in time and space. The influence of an intellectual milieu such as that provided by Paris or São Paulo is something that almost by a process of osmosis penetrates and constantly reshapes one's views of social theory and of the world. Also, crucial events, such as the explosion of the space shuttle Challenger, would call for modifications to certain theoretical notions that I had thought already "fully developed." The shape of a final text has much to do with such influences.

The inputs of certain individuals have also left their marks; to cite some by name: Plenum Series Editors Arne Kalleberg and Ivar Berg, David Buxton, Adrian Raftery, Maurice Godelier, Bill Willmott, Sami

Dassa, Dan Berman, Bob Gidlow, Katy Richmond, and especially Geoff Fougere and Allan Levett. These people have, either by reading drafts, discussing ideas, or pointing in certain directions, contributed to the book. Gratitude that goes back to a distant past when Raphael Samuel and Maxine Berg in England gave some crucial clues and support in my first primitive attempts to understand the history of accidents must also be expressed.

The initial ideas that gave rise to this book were brought together in a doctoral thesis that was defended in a public "trial by jury" in Paris in December 1978. M. Jacques Lautman suggested that future research be conducted in more controlled environments than those studied in my research of the construction sector. This suggestion influenced the shape of future testing of the theory. M. Alain Wisner, who would later kindly provide further guidance and support, developed arguments that would force me to be more attentive to the work that other disciplines, and in particular ergonomics, were doing in the field. On that same day a number of points of ongoing debate with my thesis supervisor, Alain Touraine, would be aired. Over the years, M. Touraine has been both patient and generous in his encouragement of this research. His remarkable sociological intuition has helped push the research forward in new directions and his perceptive critical comments have served to guide me out of many a theoretical jungle.

Should I appear to the reader to have flawed reasoning, or to be lost or without direction, the responsibility is no one's other than my own.

TOM DWYER

Contents

Introduction

The initial intellectual motivation behind this book was an attempt to integrate the study of "life and death at work," the study of industrial accidents, and the knowledge acquired in the sociology of work. In so doing it was ascertained that accident analysts and preventers could be more effective if their reflections included reference to explanatory insights that are sociological in nature. During the course of writing this book, industrial accidents would come to appear as little more than a metaphor for those errors that modern societies systematically produce through work. Viewed this way, the insights developed herein may be applicable beyond industry and its systematic production of accidents, waste, and other "undesirable" outputs. They may be of use in analyzing phenomena such as scientific fraud in laboratories, sentencing errors of the judiciary, dropout and failure in schools, or medical error in hospitals. Using the notion of a metaphor, new angles of reflection on the "crises" in contemporary medicine and education might be developed by focusing on the capacities of hospitals and schools to regularly produce undesired outputs.

Against the background provided by this broadened focus, a sociology of industrial accidents can be seen as a sociology of a particularly "hard" or "violent" phenomenon—a phenomenon born, in the form we currently perceive it, with the birth of industrial society. To combat accidents, technique and legal–rational authority were mobilized, institutions, disciplines, and professions developed, and the instruments of a rationalizing and modernizing society applied. Through this process social actors were transformed into instruments of, or impediments to, modernization. Accidents would thus, like many other modern "social problems," come to be treated as an aspect of economic and social development that escapes the control of the rationalizers. Reference to the

role that the very work relations that edify industrial society play in producing accidents would be eliminated and victims would be blamed, scapegoated, marginalized, forgotten. From the end of the 1960s a profound crisis and reorganization has occurred with respect to accidents. The rationality behind the phenomenon's management is challenged and, by association, the basic assumptions of the modernizing and rationalizing approach which underlie this management come to be questioned. One approach to reading this book is to see it as an attempt to build an alternative vision of accidents, of the institutions and the society that accompany them, and, by analogy with these, to use accidents as a prism through which to view rationalization and modernization.

LIFE AND DEATH AT WORK: THREE INSIGHTS, ONE CONTEXT

Changing Images of Work Accidents

Seveso, Bhopal, Flixborough, Chernobyl, and Three Mile Island are names that have recently evoked images of massive destruction of civilian populations and the fear of things to come. Each was the result of an accident occurring in industry.

In the early part of this century the visible face of accidents in industry was expressed through a different list of names: Courriéres, Senghenydd, and Monongha—mining disasters that killed large numbers of workers without threatening civilian populations.[1]

These two lists convey the image of a spectacular transformation between the beginning and end of the twentieth century. Accidents that kill large numbers of workers no longer seem to occupy the attention they once did in public consciousness. This attention is now occupied, in the advanced industrial nations, by threats to the lives of nonworking populations. This change has occurred even though accidents of the latter type claim the lives of far fewer nonworker victims than the former continue to claim of workers. Elements of this transformation are examined in Chapters 1, 2, and 6. The production of both types of accident, whether they occur in mining, construction, or nuclear energy, will be rendered analyzable by reference to a sociological theory of accidents that is developed in Chapter 3.

A "Near Miss" Accident: The Original Motivation for Sociological Inquiry

The manager of this construction site always said to his workers, "Your safety is our number one priority." His second-in-command wore a green cross, insisted that helmets be used, checked equipment, pinned

up safety posters that would exhort the workers to look after themselves, and accompanied the government inspector during his site visit. But in spite of such activity, a number of worker complaints aired at safety meetings would remain unattended. However, another set of processes also operated. The multistory building was nearing completion and fines would soon be levied should crucial contract deadlines be missed. This meant that all workers were asked to work overtime, frequently 3 hours overtime on the long summer weekdays and 8 hours on Saturdays and Sundays. With time and a half being paid after 40 hours per week and double time on Sundays, pay envelopes were enormous. But the city of Wellington, New Zealand, is not called "windy" for nothing, and the summer northwesterlies were causing delays in a particular task: repairs to external panels damaged during installation were running well behind schedule.

These panels were reached by ascending the building in twos on a wooden swinging stage; upon reaching the location where work was to be executed, the stage would be moored to the building. Repairs were made by mixing and applying a cement, sand, and stone compound so as to reproduce the original shape and look of the panel. "Five dollars or more just might turn up in your pay packet if you show initiative," said the site manager in one meeting. Such payments were made "under the table," included in the pay packet under the rubric of extra hours worked. Laborers who, among other things, went up the building in windy conditions would receive them.

It was in such a context that one day the stage of a workmate and myself was caught by a violent wind gust as we descended the building. It swung so far over the street that we were lucky not to have fallen out. Such an experience, initially pushed into the farthest reaches of my memory, would come back later to motivate sociological inquiry.

When a "near miss" or an accident is treated in the safety literature, it appears in terms quite different from those I have just used. More often than not workers engaging in an activity such as the one I have described would be blamed. Reference to the role of bonus payments would simply disappear. Such payments are, however, discussed extensively in sociological studies of work. As we shall see later, some sociologists have tried to establish links between accidents and bonus payments. But accidents, like work itself, are produced by more than just incentives. To what extent could insights from sociology help produce a new understanding and perhaps contribute to reducing accidents? Armed with a heterodox training, one quite fitting to the time and place of its acquisition, training in business administration, symbolic interactionism, structuralist and Marxist anthropologies, organizational sociology, and theory building, I would carry out an ethnographic study

on a New Zealand construction site as part of my graduate research.[2] This would provide initial insights, some of which shall be taken up in Chapter 3, into what would later become a sociological theory of industrial accidents.

The Casting of a Shadow: The Distance between Emergent Sociological and Modern Approaches to Safety

Safety specialists, research, unionists, government inspectors, industrial nurses, employers, and the likes of safety posters and safety campaigns all seemed to portray accidents in a way impregnated with rationalistic criteria and generally to denounce the irrationality of victims. Personal experience in a series of manual factory jobs and the views of workmates and of those who I would later research in both France and New Zealand would be so distant from those of the "modern approaches" that a shadow would come to be cast over the very validity of an attempt to develop sociological explanation.

Yet, strangely, the idea that accidents are produced by social relations of work seems such an obvious one. How could it be that accidents are most commonly thought about in terms that define them as non-social, as produced by individual workers or their machines? In searching for a reply my initial focus of investigation was historical and eventually expanded beyond the original question, leading me to examine a larger set of interrelated themes in the first and second chapters. Much later, particularly in the sixth chapter, the focus expands yet again, this time to reflect on the making of tomorrow's history, tomorrow's accidents, and to seek to build an image of the conditions under which insights drawn from a sociological theory of accidents might become a widely accepted guide for preventive practices.

The structure of this book emerges from three central insights on accidents: one provided through personal experience, one relating to the distance between such experience and dominant contemporary reflections on accidents, and a concern that disaster accidents and public perceptions of accidents have undergone important transformations in the course of the twentieth century. These insights are crucial for setting the context of this book, in which I attempt to integrate them into a unified expository and explanatory scheme.

A CASE OF SOCIALLY PRODUCED ERROR: INDUSTRIAL ACCIDENTS

The first chapter poses several very general questions. How can the rise of one modern notion of error, the industrial accident, be under-

stood? How does its appearance as a "problem" relate to cultural change, transformations in notions of interest, and in capacities to process and manipulate information?

From this point on the questions, for a sociologist, become more specific: in what ways is the problem treated and how do different social actors define treatment; and what resources are drawn on and what forces are mobilized, rejected, and demobilized in the construction of models of action that eventually become dominant? Can elements be located that may limit or serve as bases from which to expand the scope of future action from within the dominant models that form? These questions are sufficiently general to guide research into the historical origins of other modern notions of error.

A particular empirical focus of such questioning is the country that was the cradle of industrial civilization—England—and from where many institutional innovations were later copied by other nations. The empirical material for the chapter is provided by the British coal mining industry, the only industry about which I was able to locate adequate documentation. However, reference is made, where appropriate, to other industries and countries.

The chapter's title, "From Sin to Social Peace," portrays the transition surrounding the treatment of accidents between the sixteenth century and the beginning of this century. Through accident compensation, this transition would give birth to the first institution of the modern welfare state. Through safety legislation and inspection, it would help consolidate notions that underlie the activities of the modern bureaucratic and interventionist state. Through the development of technically conceived safety measures, power would come to be vested in professionals and other administrators of safety standards.

The title of the second chapter, "From Peace to Rupture," sets a tone that is specific to the world of accidents. This world, which had developed quietly for nearly a half-century, would come to be characterized by extensive institutional reform and social mobilization from the end of the 1960s in many industrial nations.

One question asked in this chapter is what occurred between the period when social peace was consolidated and the period when it broke down: what institutions were built, what did they do, how did they respond to demand for their services, and how did they differ from one to another? A second question is whether the analysis of the interventions, internal functioning, and change of the institutions permits sociological insights to be developed into the nature of the future breakdown and rupture in social peace? One particular concern underlying this chapter is to analyze these institutions in order to permit the recomposition that occurs subsequent to the rupture to be better understood.

At an abstract level these questions and concerns attempt to trace forces of continuity and transformation of institutions in contemporary societies through the analysis of some very specific problem-focused institutions, their interventions, internal functioning, and change.

Compensation and safety legislation, safety engineering, ergonomics, industrial medicine, and industrial psychology are dealt with. An important part of the activities of each relates to industrial accidents. Experiences in three advanced industrial countries—France, Great Britain, and the United States—provide the bulk of the raw material from which the analyses are built. Outside of specialized disciplines and government, the phenomenon of accidents had been little studied prior to the rupture. Subsequent to it, and the reactions it provoked, an unprecedented amount of accident-centered research appeared, and this book would not have been possible without it.

The sociological theory of accidents can thus be seen as a product of the rupture. Before examining it let us pause and, without focusing on dramatic cases—the Chernobyls and the Bhopals—take a brief look at the importance of industrial accidents in contemporary societies. First, it is worth noting that, like many other socially produced errors, they frequently appear to be shrouded by a veil of silence.

Accidents as a Social Problem

Eight times as many deaths result from industrial accidents as from homicide. This spectacular comparison was made in France by a group of judges.[3] In Canada, a multidisciplinary group did some simple arithmetic, calculating that 28 times as many workers are killed or injured in the workplace as citizens are by criminal assaults.[4] In advanced Western societies, however, criminal assaults and homicides make the headlines, while industrial accidents—a statistically more important form of violence against the person—do not! Strikes are constantly denounced by many in these societies as wasteful, but accidents are explicitly and implicitly treated as "unfortunate." In New Zealand, 20 times as many workdays and in the United States, 10 times as many are lost by accidents compared with those lost in strikes.[5] The number of permanently disabling injuries caused by industrial accidents far outnumber those caused by the automobile.[6] If the proportion of human carnage is not enough, the total cost of all types of accident in industry has been estimated to average 4 percent of gross national product per year (equivalent to the percentage of GNP Brazil pays for servicing its debts to foreign lenders) in advanced industrial countries.[7]

Such statistics invite if not compel one to ask how accidents have

come to be such an invisible phenomenon in industrial societies? That question can be asked at different times and in different places for other forms of error. Thus, medical error has been hidden in France. And in Brazil, even when implicated in the death of a president-elect, medical error remains relatively uncontested,[8] whereas in the United States it constitutes a major public issue. An attempt to build a sociology of industrial accidents appears justified by the phenomenon's sheer importance as a "social problem," even if its dimensions are so often ignored or overlooked.

In Chapter 3 a theory is built in which error is conceptualized as produced through the functioning of social relations. In the workplace, be it a school, hospital, or factory, a social relation is the manner in which people's relationships to their work are managed. Patients, students, workers, and teachers can be seen as actors in organizations where they produce goods or services.

This theory of industrial accidents was delineated to meet at least four criteria: (1) that it be compatible with accumulated knowledge in the field of the sociology of work, (2) that it be capable of organizing the often contradictory findings produced by accident research, (3) that it be capable of being tested empirically, and (4) that it be capable of producing an understanding of how to reduce industrial accidents.

The theory is constructed so that problems in organizations are conceived of as being produced at four levels. It then sets out to develop this conception to permit the analysis of accidents. Rewards, command, and organization are conceived of as levels of social relations and the individual member level constitutes a nonsocial level. The use of the term "level" does not imply the existence of any hierarchy; rather, the theory explicitly envisages that levels may assume different degrees of importance at different times, and that changes in such importance will be reflected in patterns of accident production. Both industrial accident literature and personal research constitute the empirical bases to which constant reference is made in the course of theory construction.

Relationships between Research Methods and Theory Construction

The theory, as built up in its most abstract sense, claims to have some capacity to explain error production in nonindustrial organizations. However, this cannot be taken as a suggestion that the word "accident" can be simply "translated" into the word "error" and valid hypotheses derived accordingly. Rather, building theories of other forms of error will involve an important inductive component that will serve to remold initial ideas, as was the case with accident theory.

The interaction between theory and research methods was of the utmost importance in building a theory of accidents. Empirical research influenced original theory construction, and subsequent empirical research and research findings contributed, on various occasions, to revising the theory. It was only possible to develop a certain number of theoretical insights because the research methods chosen permitted an unconventional perception of accidents. By now turning to an examination of research methods, it is hoped that the foundations of Chapter 3 will be better understood.

Michel Crozier has discussed two classic approaches to the study of organizations which he calls structural and case study approaches.[9] The first approach assumes that "structure" is the only variable capable of affecting the "output" of error in societies and their workplaces. Structural variables, drawn from disciplines such as engineering, psychology, or from regulatory approaches, thereby come to be seen as explaining increases or reductions in error rates. Many such studies assume that a single variable explains changes in rates. In spite of their frequently simple causal models, some interesting results can be found. For example, a series of early British psychological studies linked important drops in accident rates to reductions in working hours.[10] Other studies are less interesting from the point of view of prevention: the underground mining sector is shown to be consistently more dangerous than automobile assembly, and lower-class students have a consistently higher dropout rate than middle-class students.

However, structural studies have produced many confusing and contradictory results. The relationship between technology and accidents constitutes a typical example. Attendees at an international conference examined the theme and concluded that some technological changes are associated with lower rates and others with higher rates, but no one could specify which changes produce which results![11] In hospitals sociologists have attempted to measure error rates by referring to "quality" or "performance," and such notions are measured and attempts at prediction are made through reference to a variety of independent structural variables. After many years of research using such an approach, Flood and Scott observed that

> [m]ost studies of the quality of care rely on either structural or process indicators: measures of hospital facilities or personnel qualifications are frequently employed to assess structural quality, and measures of autopsy rates or numbers of tests ordered are often used to measure the quality of care processes. . . . [T]he appropriateness of using structural or process variables as surrogates for outcome measures is severely challenged by our analyses, which show low and inconsistent correlations between structural features and procedures presumed to be associated with better health care and measures of health outcomes.[12]

At a higher level of abstraction, where different sets of national data are examined, the structural variables of economic expansion and contraction have been used to explain the same phenomenon—declining accident rates.[13]

A structural approach seeks to produce broad understandings of the phenomena under investigation, usually involving research carried out "at a distance" from the workplace. My initial insight was that a structural approach had made only limited contributions to our understanding of accidents largely because the ambition of the approach, and the methods that accompany the attempt to realize it, lead to an incapacity to perceive the complexities of causality.

An alternative approach to the study of work and organization exists. Crozier labels it the "case study" approach. Employing methods and concepts originally borrowed from social anthropology and social psychology, it has become the tradition of the sociology of work since the days of the Hawthorne studies. The approach is not without important weaknesses, a major one being that its isolated studies do not provide grounds for generalization. Only as a result of the accumulation of a vast number of case studies has it been possible to build systematic understandings of phenomena among which are piece work, workplace culture, strikes, and informal organization.

When I initially contemplated investigating industrial accidents, I could find no reference to sociological case studies of the phenomenon. Leading Franco-Belgian ergonomist Faverge deplored the dearth of workplace studies. He observed that the closer one gets to the factory floor, to the direct experience of the accident, the more likely it is for accidents to be analyzed as products of tangible factors in the workplace. As one moves away from the factory floor, it becomes more likely that individual carelessness will be claimed as the cause.[14] In Faverge's opinion the choice of inappropriate research methods constitutes the principal factor behind the vast majority of accidents being blamed on workers.

Flood and Scott refer to the importance of the organizational context of medicine over the structural features of its operation for understanding what they diplomatically call "outcomes": "the provision of a supportive and constraining environment . . . may be a more significant contributor to the quality of work than the type of past training or length of prior experience."[15] By conceptualizing the notions of a "supportive" and of a "constraining" environment sociologically, by engaging in hospital case studies, research into medical error might come to break new ground.

Following on from Faverge, a case study approach to accident research would appear likely to produce representations and explanations

of accidents that differ from those produced by structural studies. It is in such a manner that I consider my earliest decisions to adopt this approach to be justified.

In the course of carrying out successive studies I became convinced that, given the exploratory nature of the emerging theory, it would only be with great difficulty that hypotheses derived from theory could be operationalized for testing through recourse to a structural approach.

Chapter 4 discusses, initially at a general level, both criteria of explanation and criteria of research design. Based on such considerations, a decision was made to research factories where shifts are worked. Such work is considered semiexperimental because when a company works rotating shifts, for example, the staff manufactures the same products, uses the same plant and equipment, but does so at different times of the day. Such variations in accident rates as occur between day and night shifts cannot therefore be explained through reference to traditional factors such as the staff's psychological characteristics or by reference to the state of machinery or other such engineering-related factors. Some accident research literature provides grounds that reinforce this decision to investigate shift work.

In Chapter 5 the shift work study is discussed. Qualitative data from three of the seven plants researched are related in some detail, and both social relations and accidents are shown to vary between shifts. Hypotheses derived from the theory are tested in both qualitative and statistical senses. Such testing indicates the promising nature of a sociological approach.

The final chapter, true to its title, "Readjusting the Prism," discusses the recomposition of institutions, the arrival on the scene of threats of new accidents, the emergence of new approaches, and other important events that occurred during the 1970s and much of the 1980s. These were years of crisis and renewal of the interventions of professionals and government in many areas of life in the advanced industrial nations. Such a generalized phenomenon suggests that a theoretical referential that is more general than that provided by the narrow question of accidents should be maintained. Alain Touraine's notion of postindustrial society proved sufficiently powerful to serve as a theoretical apparatus around which an understanding of many ideas and events, both internal and external to the question of accidents, could be integrated.[16]

Chapter 6 attempts to discern the social and political bases for the emergence of new practices that are capable of dealing with accidents. During this process the bases of potential political support for a sociological conception of accidents are identified. This chapter is written in the immediate hope that concrete social actors and social relations will

come to be more widely seen as responsible for accident production. It speaks of changing the conceptions and practices of those responsible for what is today called accident prevention but who, if they continue to explicitly deny the role of social relations, should be called on to assume responsibility for the consequences of their actions. In so doing, it speaks not only of changing work relations that claim the lives and limbs of millions in industry but also of changing those relations that produce the Bhopals and Chernobyls that threaten us all.

In the Afterword possible parallels between accidents and errors, noted only in passing in the course of the book, are discussed more specifically. It is suggested that the accident metaphor is capable of making a contribution to the reconstruction of our images of modernized and rationalized societies. Such reconstruction (or its absence) informs the action of society upon itself, and in this manner makes a contribution to the way in which societies build their futures.

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1

From Sin to Social Peace

The Origins of the Modern Treatments of Industrial Accidents[1]

The movement from craft and agricultural work to industrial labor brought about transformations in work relations.[2] British mining has been subjected to well-documented changes: three peasant workers gathering coal in open cast operations using simple iron tools and a bucket[3] gave way to large numbers of people working for wages, under supervision, and with a need to develop knowledge about their underground work world.[4]

Globally, work moves from being managed through reward systems to being managed through control of the division of labor and its coordination.[5] Early miners, and those around them, spoke little of accidents[6]; according to Paracelsus, workers were simply devoured by demons.[7] Others saw accidents as inevitable.[8] Perhaps the silence surrounding accidents can best be understood if one looks at the general notion of causality operating: in the words of Ricoeur, "if you suffer, if you are sick, if you fail, if you die, it is because you have sinned."[9]

Underground mining opened up new sources of accidents. In 1662, a Mr. Power delivered a paper to the British Royal Society in which he reported that it was only after the first person let down into the pit on the rope "is presently killed" did they find out, by "the letting down of dogs . . . or more frequently candles, when the pit is unfit to enter."[10]

Barrington Moore said that for politically effective moral outrage to occur, ". . . people must perceive and define their situation as a consequence of human *injustice,* a situation they need not, cannot and ought not to endure." Denial of the legitimacy of suffering occurs when the "causes of misery appear to the sufferers as due to the acts of identifiable superiors."[11]

In 1662 miners in the Tyne Valley "first united to protest against the treatment afforded them by colliery owners." They complained that their requests for ventilation had been systematically ignored by the owners, and demanded protection against accidents which had become "so frequent in the district."[12] In this incident, we can see that workers had broken with any notion that accidents are a punishment for sin. Employers are seen as the producers of accidents, and this is considered *unjust*.

It is only much later, however, that a well-founded idea of the nature of changes in work relations and changes in the production of accidents could be developed.

THE BIRTH OF THE MODERN NOTION OF INDUSTRIAL ACCIDENTS

Between 1800 and 1840, the mining labor force in Britain rose from 40,000 to 143,000.[13] How, during a period of such rapid expansion, was the knowledge necessary for effective task execution developed? We learn that on the job and through the sharing of information, miners rapidly generated "pit sense": some learned the smell of theoretically odorless firedamp or how to identify hidden strata and seams in the mine by tasting water. "To take notice of minute warning signs, sounds, and smells," they developed what could be called a "sixth sense" with regard to safety.[14] For Raphael Samuel, this process was part of a more general one by which nineteenth-century capitalism created many more skills than it destroyed. "In coal mining activity increased by the recruitment of a vast new class of workers who were neither exactly laborers, nor yet artisans, but who very soon laid claim to hereditary craft skills."[15]

In developing their knowledge and consolidating it in a "craft" tradition, they produced a sense of *truth*. Combining truth and justice, whether as miners or as community dwellers, they developed their cultural tradition, the importance of which is reflected in their music, lifestyles, and struggles.

This cultural tradition can also be seen in novels and in the pages of various commissions of inquiry into living and working conditions of segments of the popular classes.

The Children's Employment Commission

The report of the Children's Employment Commission was published in 1842. The Commission had conducted its investigations against

the background of scandals over children's employment and of great political unrest, as the banner of Chartism was held high.[16] The pages of its report provide rich insights into conditions and social relations in the coal mines, and "there is much to be learnt from the report . . . about the circumstances of accidents."[17] Through reading testimonies of certain miners and other witnesses, the existence of a fragmented, but frequently shared, perception that accidents are produced by what contemporary sociology might call "work relations" becomes apparent.

Grounded in this perception of cause, the witnesses can be interpreted as identifying a number of components of work relations as associated with workplace safety: the ability to generate and transmit knowledge about the workplace, the refusal of financial incentives, the ability to resist authoritarianism, and the reduction of working hours. Frequently dangers were seen in the ignorance, stamina, and vulnerability of both younger and female mine workers. These fragmented conceptions, when integrated, express the idea that a greater control over the management of work by knowledgeable workers, one that allows them more freedom from financial necessities, from arbitrary employer action, and from ignorance, will reduce accidents. Such perceptions reflect notions of dignity, autonomy, justice, and the value of knowledge and are counterposed to a world of production that denies them.

An Empirical Accident

Let us look at one accident that illustrates a number of the more general points just made. The example demonstrates the importance of "pit sense." It shows an attempt to communicate dangers to employers being repressed by authoritarianism, a group of workers exercising their autonomy, and (as a consequence of their knowledge) withdrawing from the mine. Others, however, continue to work with the danger, their autonomy for action subverted by the financial rewards offered. The Commission's report relates: "The accident, which occurred in Mr. Curwen's pits near Workington, about two years ago, from an irruption of the sea, was foretold by many. It appears that the seam of coal rose under the sea, so that in working it every step brought the colliers nearer to the water. The salt water is said to have oozed through, and some of the men had heard, or said they heard, the sound of the sea above them."

An underground steward related: "My uncle, William Thornton, was an overman . . . and he warned . . . the steward of the probability of the sea breaking in, and was discharged in consequence." The account continues: "so great was the apprehension that some of the col-

liers left their work, and others were induced to stay by a higher amount of wages. At length, the water rushed suddenly in, and though some who were near enough to the entrance escaped, about forty fell victims, and remain to this hour in the pit."[18]

The accident was *unjust* since it resulted from the actions of superiors who offered incentives for workers to act in a situation that their sense of *truth* told them was dangerous.

However, it would be a big mistake to think of all miners as carriers of a cultural tradition, charged with strong notions of truth and justice, that would lead them to claim that their exposure to danger was a social product. What we find is a large degree of fatalism about accidents. Part of the time, the weight of traditional ideas about the accident—that it was a punishment for sin—prevailed. The rest of the time, the accident was ignored. The chief constable of Oldham summarized the reaction to work deaths: "In a day or two's time among such people, even their wives and children seem to have forgotten. They will say at the time, 'Oh, I am not a bit surprised—I expected it, I expected it,' and it soon passes by. There are so many killed that it becomes quite customary to expect such things. . . . The colliers . . . learn *which* it is that is killed, that is all they think about it."[19]

I shall label these two types of worker in terms of their representations of accidents, the latter as the *fatalistic worker,* the former as the *autonomous worker.*[20] Theirs are not the only representations to be found among miners but, at this stage, are the most important ones.

On the employers' side, an important distinction can be drawn between the carriers of two separate orientations to prevention. One is held by what I shall call *traditional capitalists,* the other by *industrial capitalists.* Traditional capitalists believe that profit is made through obtaining labor at the lowest price possible and minimizing investments. This is compatible with the orientation discussed by Hobsbawm, whereby "the lowest wage bill for the longest hours meant the lowest labour cost per unit of time."[21] For these employers, accidents were seen as entirely the worker's fault.

Examples abound in the Commission's report as to how employers economize on safety: investments like the lining of shaft walls to prevent stones falling are refused,[22] sufficient wood for adequate roof and gallery propping is denied,[23] ropes used for haulage are not renewed as necessary,[24] pit entrances are not protected.[25] But it is not enough to confront workers with defective working conditions or inadequately skilled workmates; employers must ensure that they work with these. A 69-year-old miner, Joe Warrener, reported that this was done by resort to authoritarianism: "if the men complained they would be turned out of employment and might work no more."[26]

One example can illustrate how accidents resulted from this orientation held by traditional capitalists:

> But there is a class of accidents of which children employed at coal-works in the neighborhood are the cause to persons of all ages. These occur in the winding up by steam machinery of all persons out of the pit. It is a general system here to employ mere children to tend these engines, and to stop them at the proper moment; and if they be not stopped, the two or three or four or five persons wound up together are thrown over the beam and down back into the pit again. The inducement to employ these children where life and death depend on their momentary attention is merely that their services can be obtained for perhaps 5s. or 7s. a week, instead of 30s. a week which the proprietors would perhaps have to pay to a man of full years and discretion.[27]

Another type of employer, the industrial capitalist, treats production and safety in a different way. Joseph Bryson discussed the treatment of winding in the Broadway Lane Colliery, where he was a bookkeeper:

> The engine employed at these works is high pressure, and managed by an adult: it is not because the engine is high pressure that an adult is employed but because of the danger, in employing young people, that they may wind over the coals and the men. . . . The engineer has 18s. a week . . . these wages are paid entirely for safety, in preference to employing children and young persons, as is the case with other employers.[28]

Besides investing in skilled labor, this type of employer bricked shafts,[29] changed ropes regularly,[30] protected elevators,[31] and incurred other expenses in order to ensure greater profits. The defining mark of the industrial capitalist is an orientation to invest in working conditions in order to increase productivity and hence profits.

The Birth of Safety Engineering: Employers, Workers, and the Davy Lamp

Having characterized four types of social actor, let us look at one of the first, and certainly the most famous, industrial safety device: the Davy lamp. (This examination will allow a number of insights into the operation of safety standards to be drawn, which are important for understanding some of the limitations of safety management that appear at the end of the twentieth century.) To develop these insights, a series of suppositions as to how various social actors might have related to the Davy lamp and a reflection on the implications of different actions for industrial safety and its management are combined. This lamp, along with investment in improved ventilation, played an important role in the drop in accidental deaths due to explosions in northeastern England:

from 5 to 6 workers per 1,000 per year at the beginning of the nineteenth century to 0.9 in 1850–1853.[32]

In 1815, the Society for the Preventing of Accidents in the Coal Mines, made up of mine proprietors (industrial capitalists) in northeastern England, asked Humphrey Davy to do something in order to lower the rate of explosions and the high costs these implied.[33] Within a few weeks, Davy had invented a device designed to lower the temperature of the heat emitted from miners' lamps and thereby reduce, independently and automatically, the risks from the ignition of explosive methane.

For a technical accident prevention device to be accepted and used in mines, three conditions must be fulfilled:

1. Employers must be conscious of its existence.
2. Employers must be oriented favorably to invest in it.
3. Workers must accept to work with or use the device.

From the beginning, barriers to the lamp's acceptance can be hypothesized. Without a developed press, some proprietors would not have known of the lamp. Traditional capitalists would reject it because, given their notion of productivity, it would be seen as irrelevant. Some industrial capitalists would reject investment as wasteful for the simple reason that the risks of explosion in their mines were low. Among workers, some of those who have been called autonomous and perceive a link between their independence and safety could be expected to fear that the lamp's introduction would reduce their autonomy since owners might use it as a technical substitute to their judgment.

But faced with such obstacles to the rapid spread of the lamp, Davy would hardly have been despondent; a proponent of the principles of the Enlightenment, he had once pronounced, "The seeds of progress are sown in the mind and often remain invisible, but the Spring will come sooner or later which will make them grow."[34]

The lamp was introduced into the mines from 1816 onward. In some of them, there can be no doubt, authoritarianism would have been used to break opposition from autonomous workers. But it would be wrong to think that the only workers to have spontaneously accepted the lamp would have been the fatalistic ones. Many workers at the beginning of the nineteenth century, particularly those in the crafts, believed that science could be a tool for human emancipation. They formed Mechanics Institutes and Halls of Science and segments of them were linked with all types of radical organization.[35] I will call those workers who actively favored the use of technology as a means of improving working conditions *industrial workers.*

Safety Engineering, Social Action, and Accidents

Using Hair's skillful analysis of early mining accidents, we can fit data to hypothesized situations. Where there exist industrial capitalists oriented toward, and capable of, imposing the lamp's use on workers (and also other types of investment against explosions), or workers who accepted such investments, there should be a drop in the rate of explosions. In northeastern England, the rate of deaths due to explosions dropped from 5 to 6 per 1,000 workers per year at the beginning of the century to 0.9 per 1,000 in 1851–1853.

Where there were traditional capitalists, and the absence of a successful struggle by industrial workers to impose a new employer orientation, the lamp and other antiexplosion devices would not penetrate quickly into the mines. Lancashire was a region recognized for its gassy mines and its employers were reputed not to be "progressive." In 1851–1853, it experienced a 2.7 times greater accident rate due to explosions than the northeast, 2.4 deaths per 1,000 workers.

But two further phenomena can be observed: first, where the technical prevention methods developed are inappropriate for combating certain technically defined accident causes, inequalities will emerge. Second, the employment of a given prevention method may be associated with the production of new types of accident.

Illustrating the former phenomenon: in the Black Country, accident rates from all sources were not reduced between 1838 and 1851–1853; these remained stationary at 7.0 deaths per 1,000 workers, a total higher than in any other region of England. Here, explosion prevention techniques could never have played an important role in reducing accidents, since in 1838 they killed 0.9 workers per 1,000 in this virtually gasless region and, in 1851–1853, claimed 1.1 victims in every 1,000 workers. In this region, the major technically defined accident cause was roof falls, which claimed 3.6 lives in every 1,000 workers in 1838 and 4.1 in 1851–1853. In the absence of measures to reduce this particular technically defined cause, inequalities had developed between gassy and nongassy mines, the former being able to reduce their rates by available technical means, the latter not.

The literature allows us to see the opposition of autonomous workers to the Davy lamp and how its introduction was associated with the production of new accidents. One of the reasons for the lamp's introduction was to permit the exploration of deeper seams. The 1835 Select Committee on Accidents in Mines examined the situation in Durham and Northumberland and found that in the 18 years before the lamp's introduction, 447 lives had been lost compared with 538 in the subse-

quent 18 years.[36] How is this nominal rise in accidents explained? It is not explained by the fact that safety devices sometimes directly produce accidents.[37] Mr. Thornley, a magistrate, perceived that miners (and autonomous miners had foreseen this danger in their early objections to the lamp) were being forced to work in places that previously had been considered unsafe because they were too gassy.[38] How this happened—either through employers resorting to authoritarianism or through their offering incentives to workers—we do not know; the important effect is that the lamp substituted for the worker's judgment. The risks of working in bad air found at deeper levels increased as overall risks from gas explosions declined.[39]

The Birth of the Power to Dispose of Danger through Technology

From a numerical standpoint, accidents examined by the 1835 Select Committee had risen; however, had the statistic been expressed as a rate, they would have been seen to have fallen. It is important to address the paradox contained in this discovery that safety devices are implicated in the production of new accidents. The following analysis of what shall be called the "new accident effect" has been influenced by Quere's book *Des Miroirs Équivoques*.[40]

Before the development of prevention techniques designed to treat risks in a technically measurable or standardized form, workers' orientations to work or not in a given situation were developed in function of their conceptions of truth and justice. Neither of these was determined by the employer, who, faced with worker refusal to complete a certain task, could resort to measures such as authoritarianism or financial incentives to guarantee performance. That is, the employer could reply to workers only through the visible exercise of power. The workers' sense of truth was opposed by a visible manifestation of injustice. Any disagreement between worker and employer opened up the possibility of conflict. Production was not predictable as workplaces were full of "indiscipline" around any controversial questions. Safety, as the refusal to work prior to the Workington Colliery accident illustrates, was just one such question.

To be able to plan work and to rationalize it, there has to be a rupture with a cultural tradition that leads to conflict. A progressive sector, industrial capitalists in alliance with science and technology, was able to find a manner of breaking the cultural tradition. E. P. Thompson has demonstrated that traditional notions of time were altered with the advent of the clock[41]; in an analogous fashion the Davy lamp served as one tool for breaking down currently held notions of safety.

A technical instrument, the Davy lamp is conceived of in such a way as to make the control of one specific task danger measurable and visible. The lamp is designed so that a wire gauze mesh surrounds its flame. A gauze of a certain size guarantees an automatic and measured reduction in the temperature of the flame as it arrives into the atmosphere that is potentially filled with methane gas; this reduction is sufficient to permit the gas to burn at a temperature below its explosion point. A previously invisible danger is visibly controlled for. Until the introduction of safety devices, dangers had been calculated, however imperfectly, by the senses of workers on a day-to-day basis. In the mines, such calculations formed a part of pit sense, whereas in more traditional crafts they formed an integral part of skills. It is the constant and empirically verifiable reference to a device designed to be a visible and measurable indicator that dangers are being controlled for that, initially, lays the basis for its acceptance as an "objective" and durable indicator. (Such instruments would later expand to control for factors such as ventilation, tunnel propping, height, human reach, and horsepower. Not only technical devices, but also rules, will make up the battery of instruments.)

This property of "objectivity" allows both workers and employers to refer to the instrument for confirmation. "Power" is vested in it, and both parties are bound by it. The production of knowledge is exteriorized from the workplace in a radical fashion.

A "mere" technical device now provides the distinction between "judgments of fact" (e.g., the Davy lamp controls the dangers of methane, i.e., whether one aspect of the task is safe) and "value judgments" (whether the worker "feels" the task is safe on the basis of pit sense). When the objective performance of the lamp becomes more important than criteria of truth and justice, it becomes the new legitimacy. A refusal to work is combatted with an instrument, work is gradually objectified, and thus each such instrument undermines a part of the cultural tradition. The power to technically dispose of danger is born, and with it the cultural tradition that sees danger as a social product, that produces moral outrage among workers and seeks to change danger socially, is corroded.

Six Effects of Technically Conceived Safety Instruments

From the discussion of the Davy lamp we have observed five and can deduce a sixth effect of the introduction of a technical safety device on accidents:

1. Where the device results in a lower rate of a technically defined accident (this can be called *the effective investment effect*).

2. From the previous effect it can be deduced that the use of the device might not result in a lower rate of a technically defined accident (this can be called *the ineffective investment effect*).
3. Where a technically defined accident exists but a lack of investment for its prevention results in a high rate continuing (this can be called *the noninvestment effect*).
4. Where the technically defined accident does not exist, the technical measure either will not be applied or if applied will prove unable to reduce accidents, a gap is produced between those subject to the effective investment effect and those not subject (this can be called *the investment inequality effect*).
5. The application of a technical measure can result in new types of accidents being produced (this has already been referred to as *the new accident effect*).
6. The workers' notions of truth and justice are undermined (this can be called *the undermining of workers' notions of truth and justice effect*).

A TURNING POINT

The application of appropriate instruments to one technically defined cause may occur at the same time as new production methods are invented that result in new accidents. "In coal mining the introduction of pillar working increased casualties from roof falls"; this occurred at a time when explosions were being reduced.[42]

Notwithstanding the reservations so far expressed about technical safety instruments, these can and do contribute to reductions in accidents. Their acceptance, however, cannot be expected to occur without conflict.

By the middle of the nineteenth century, the world's most important industrial power reached a turning point and three distinct models of industrial safety began to emerge. In one, industrial capitalists sought to increase productivity by investment in working conditions, of which safety devices constituted an element. In the second, traditional capitalists refused to invest in safety because it was deemed irrelevant to profit making. Finally, for autonomous workers, their exercise of autonomy produced greater safety.

The Victory of the Industrial Capitalist Model of Prevention

The industrial capitalist model eventually won out and became the prototype for industrial safety the world over.

Capitalists: Struggle and Consolidation

The development of an active alliance between industrial capitalists and industrial workers appears to be the political basis for this final outcome. The struggles of industrial and autonomous workers in favor of safety push employers to adopt certain measures. This struggle is defensive to the extent that it defends safety in the workplace and is offensive to the extent that it proposes autonomous worker control of safety or to the extent that it proposes the use of technical devices. Capitalists defend their position in the marketplace and their control over worker action. They take an offensive orientation proposing either investment in working conditions (in order to develop greater safety) or the laissez-faire ideology (that safety be left to the individual capitalist's choice).

Some capitalists are pressured to act, particularly when the costs incurred by accidents are perceived as threatening their financial strength in the marketplace or because social conflicts around safety-related issues threaten production. Because capitalists defend their control over their labor force, the only viable solution that exists for them is to invest in safe working conditions.

But this solution carries within it a potential problem: investment costs may not be recovered through increased profits. To the extent that this threat exists, employers might try to combat proinvestment pressures. It should be clear that where workers are well organized it may be difficult for employers to win. To survive in the marketplace, the only recourse employers have is to organize politically with other employers in order to seek to have investment costs to all employers raised. This strategy seeks to reduce competitive advantages accruing to those who decide not to invest in particular instruments.

Accidents were producing other effects outside the work and marketplaces, effects which I will soon treat in greater depth. Accidents and, above all, mining disasters were leaving growing numbers of widows, their children, and injured workers destitute. This led to both conservative and humanitarian critiques of the industrial system's damages. Outside the workplace, in the political arena, accidents had become a point of conflict.

In the turbulent atmosphere of the 1830s, industrial capitalists organized politically. Existing laws governing the working conditions of apprentices and children were not being obeyed. In 1833, a Royal Commission on the manufacturing sector was urged to set up a state-organized inspection system, "chiefly by those manufacturers who desired to see the hours in other factories restricted to the level of their own."[43] A factory inspectorate—a specialist body to enforce such laws—was set up

in the same year. It is this body that would eventually be charged with the administration of factory safety and serve as a model for other sectors and nations. Once formed, the inspectorate entered into an alliance with manufacturers and built what Carson has described as "the closest one comes to modern factory inspection as an outright conspiracy."[44] Ostler, a leader of an organization pressuring for factory reform, threatened armed insurrection in 1836. This threat resulted in defections from the reform movement. Defectors moved toward the inspectors who, under instructions to enforce the law and strengthened by allies drawn from a variety of sectors, began to act as a separate interest.[45] Their reports revealed lawbreaking and recommended reforms. By 1838, the conclusion that limits needed to be placed on freedoms so that abuse by traditional capitalists could be avoided was reflected in *The Times:* "What the humane and honourable masters have chiefly to apprehend is a competition at home, not of skill and industry and prudence and capital, but of overreaching avarice."[46]

This early development of laws and inspections can be interpreted as having been a victory for a nascent faction of the ruling class, industrial capitalists. Relations between itself and traditional capitalists had been transformed, perhaps for the first time, through state intervention. Relations between factions of capital are regulated through the imposition of certain universal, even if narrowly defined, relations between capital and labor.[47] In the early days, factory legislation only dealt with the hours, conditions, and education of apprentices and children. It was only in 1844 that it began to demand serious material investments in factory safety.

In coal mining, subsequent to an inquiry held toward the end of the most important Chartist agitations, a law was passed. In 1850, and following up on an 1842 act, the Coal Mines Inspection Act was passed. Its intention would be strengthened by two further acts in the space of a decade, the aim of which was to impose a limited number of safety-related standards on the entire sector.[48] It constituted an early, yet small, victory of industrial capitalism against the strict laissez-faire doctrine defended by traditional capitalists.

The traditional capitalists did not accept such defeats lying down. In the face of the Factory Acts of 1833 and 1844, judged by Bartrip and Burman to have been far more effective than the early mining acts, they fought back. The most public example of such action came in the formation of a National Association of Factory Occupiers in 1855. The association's activity was directed especially against the effective administration of factory laws. In 1856 it succeeded in getting a bill passed into law that removed an owner's responsibility to fence all transmission machinery.

Charles Dickens christened it "The Association for the Mangling Of Operatives."[49] In Parliament its representatives opposed safety legislation. Covert opposition was manifested through the removal of work from registered to unregistered locations far from the eye of the law, which modified industrial structures.[50]

By 1864, the social movement that represented the interests of industrial capitalists was seeing its position increasingly accepted. The world's largest calico printer told the Social Science Association that "the Factory Acts were opposed by many of us as economically unsound and as an unjust interference with the rights of labor and capital. *They have been soundly beneficial.*"[51] In the same year, the magazine *Economist* proclaimed such laws had been a wise move. However, it seems that this movement, even when provided impetus by the fears of revolution provoked by surges of political turmoil and even though backed by coalitions of humanitarian and antiindustry forces, was insufficiently strong to produce adequate factory safety laws and to ensure their enforcement.[52]

The Working-Class Movement

Where is the working-class movement in this picture? In the mines, worker demands for autonomy were replaced by trade union support for legislative action to impose technically conceived safety instruments and measures. The workers' movement proved, through clandestine organization, capable of organizing itself nationally. Alexander Macdonald founded the Miners National Union and a delegates' conference was held in Leeds in 1863. Macdonald's prime object was to have new laws passed in Parliament, and among these work safety laws.[53] The 1867 Reform Act had enfranchised many adult male workers.[54] The 1868 election was to prove crucial with the workers' movement campaigning for members of Parliament sympathetic to its cause. In the boom of the 1860s the two organized miners' movements had grown rapidly,[55] and by election time they saw numerous members elected that they had backed and Gladstone as prime minister.

In 1872, the Coal Mines Regulation Act, which developed and extended earlier work-safety provisions and raised the number of inspectors from its then figure of a dozen, was made law,[56] after a two-year delay and the dilution of some of its earlier provisions.[57] (In the manufacturing sector, consolidating legislation was passed in 1878.[58]) Technically set and standardized safety instruments, and all of, what Boudon would call, their "perverse effects,"[59] entered into the workplace only through the support of the trade union movement.

But, as we have seen, it is simply not enough to have laws: they must be enforced. In England, government safety inspection constituted an important break with past traditions, by setting up a specialized body of central government to administer a specific act that intervenes directly in the workplace. The action of safety inspectors and the treatment of offenses right up to the stage of their final judgment have been analyzed and debated in a number of historically based studies relating to factories.[60] Supplementing these with a reading of annual inspectorate reports to Parliament, one concludes that inspectors rarely prosecuted.[61] After workers in the mining sector reached this conclusion, they resorted to open and organized criticism, and this took on a highly visible form when voiced by their representatives in Parliament. They demanded increased numbers of inspectors and that workers serve as safety inspectors.[62]

Conflict over the weakness of safety laws proceeded, especially from the 1870s when workers were able to achieve greater parliamentary representation.[63] Through an examination of the content of regulations, we can see that workers' social demands were largely ignored as, increasingly, solutions to problems emerged in important political compromises that were channeled technically. Some legal changes contradict this general notion: the Ten Hour Act of 1847 and subsequent legislation mandated reductions in working hours, and workers' struggles occasionally led to further reductions. The state also regulated to combat the disorganization of the workplace and the lack of worker qualification; this was done by devising standardized requirements relating to factors such as age, length of service, testing, and training. On the other hand, piecework, long identified as a major producer of accidents by many workers, was not subject to legal restrictions. Paralleling these developments was a change in power equilibria within workplaces: the rise of workers' collective strength, particularly as reflected in increasing unionization, was making important contributions to the reduction, but not the elimination, of authoritarianism.[64] The vision that the state lent to the prevention of accidents was overwhelmingly based on the development of technical criteria, while social criteria were, with some notable exceptions, given little attention.

Accident Prevention as Political Rationality

One might suppose that problems should be attacked according to need: accidents provoked by different technically defined causes kill and injure at dissimilar rates, and from a socially rational viewpoint the most destructive of these should be the first to be treated. It appears, how-

ever, that accidents were singled out for treatment on the basis of rational criteria developed within the economic and political spheres. In the former case the commercial availability and viability of the products of scientific and technical development appears to be an important factor. In the latter, prevention appears to be primarily concerned with those accidents identified as having important political consequences—disasters constitute a prime example.[65] In other words, it appears that early safety legislation was formulated neither as a function of needs ascertained through a form of social rationality nor as a function of a perception that accidents result from the operation of social forces within the workplace. Reference to the social world is precluded in developing criteria of need and strategies of prevention.

The attention of unions was increasingly channeled away from the worksite and toward legislative change to be conquered through the efforts of members of Parliament sympathetic to the workers' cause. The power of the bureaucracy grew as industrial problems became increasingly subject to political control through their transformation into administrative questions.

Compensation for Accidents

The move toward industrial society broke down patterns of protection provided through community networks, family, ties to the land, and the guild system that were part of agricultural and craft traditions. Inextricably linked to this breakdown was the rise of individualism in all its forms and, with this, a change in the signification attached to death. For Aries, man "was already less concerned with his own death than with 'la mort de toi,' the death of the other person."[66] This change, which lays the basis for the modern-day prohibition and taboo surrounding death, has another of its bases in the increasing control over life that was one of the origins of the demographic boom that accompanied industrialization. The spread of literacy from the fifteenth century and the development of a regional press in Britain from the eighteenth century constitute further important changes. To the extent that this last process boosted the possibility of social groups sharing knowledge and forging a collective consciousness, and to the extent that it facilitated the transmission of the ideas of the scientific revolution,[67] it contributed to the undermining of the old feudal order. By altering patterns of access to knowledge, the process was also providing one of the preconditions for the spread of an industrial capitalism that had as its foundation the transformation of scientific and technological knowledge into equipment designed to increase productivity.

It was not until about 1812 that newspapers discussed mining accidents. Hair describes the prior omission as the result of "apparently . . . a deliberate policy . . . presumably in order to prevent panic among the workers. From 1812 onwards, at least the major disasters were usually reported."[68] In 1812 a mining disaster killed 92 people at Felling. Coverage by the press helped bring such accidents out of the silence of the pits and make them visible.

Increasing mining activity was accompanied by a greater number of disasters, and because of the breakdown in traditional support mechanisms a rising number of destitute victims and their dependents were produced. Such phenomena appear to have been widely identified with industrial capitalism. Such identification had its background in a range of primarily political, but also industrial, conflicts. Movements, ranging from Chartism to Luddism, troubled the dominant order in English society periodically from 1811 to 1848. They protested against pauperization, industrial brutality, humiliation, and lack of freedom. From the 1830s these movements assumed consciously proletarian characteristics.[69] They were contemporary with the period in which working conditions in general and work safety in particular entered into the sphere of public concern and action. Systematic public action around the question of compensation would only emerge later.

Benson has analyzed the compensation of accidents between 1860 and 1897 in the mining sector. He finds wide variation in the aid given to victims and their families. In the case of disaster accidents, he shows that public subscriptions were often very generous, proprietors' contributions forming a not unimportant part of these. As one proprietor observed, "if we don't contribute to the assistance funds, all the charge of the accident will fall on us . . . if we bring our contribution, I think our efforts will add to the public's generosity."[70] However, no more than one in eight of the families of all miners killed in work accidents were helped by such funds.[71]

The dependents of victims of nondisaster accidents, whether fatal or disabling, were the majority. The evidence suggests that mineowners gave money to widows of victims "to silence [them] . . . and to shut out their demands for compensation."[72] Victims of nonfatal accidents frequently lost their jobs and were left destitute. The British workers' movement was not silent in the face of these inadequacies in compensation. It embarked on two distinct strategies: one involved pursuing legal actions in individual cases and the collective pursuit of legislative changes covering compensation; the other involved setting up their own compensation funds, frequently in the form of friendly societies, controlled and managed by workers.

The early legal situation was that employers were juridically responsible for accidents, but this changed in 1837 and employer responsibility was removed whenever the negligence of employees could be imputed as the cause. In 1880, however, as the result of combined worker and political pressures, the law changed to make employers responsible for the results of negligence of managers, foremen, and administrators.[73] Theoretically at least, victims could seek some damages. However, ignorance that served as a "natural barrier" proved not to be the only obstacle to worker action. Employers brought a whole range of pressures to bear on victims, witnesses, and juries to impede the exercise of victims' rights. In spite of the trade union campaign against such pressures, and especially against workers "contracting out" of the protection available by law, they and the intimidating nature of the judicial process made workers reluctant to seek compensation. For Wilson and Levy, the British law on compensation that operated between 1860 and 1897 meant that "the compensation obtained by justice . . . [was] not a real help to the mining community."[74]

Both employers and unions recognized the inadequacy of public contributions and of recompense available under tort law. One response was the setting up of privately financed assistance funds.

In the 1860s some employers organized accident insurance funds attached to the English mines. Benson notes a certain moralism behind these initiatives, "encouraging the miner, in insuring himself, to be no longer dependent on public assistance."[75] In such workplaces the mine system of producing injury would be dissociated from the production of visible destitution. However, employers were also responding to the rising threat they saw in trade union organization. Some made joining these funds a condition of hiring, a strategy seen by Howell as an attempt to dilute bases of support for unions and to make them inoffensive.[76] Such funds were soon criticized on two grounds: their small scale did not permit them to cover the costs of disaster accidents and workers challenged suspected misappropriation of monies by employers.

Seeking to escape destitution, reliance on charity, or dependence on employer-organized funds, miners fell back on their own resources by organizing voluntary insurance societies.[77] The societies were not only an economic response to the consequences of accidents and other forms of misfortune (sickness, unemployment), but also a political response in which workers sought to build a self-organized collectivity capable of providing conviviality and mutual support, a space where they would be free from employer domination.[78] Members decided on the amounts and forms of assistance to be given. Reflecting the importance of "the other's death," the societies sponsored expensive funerals, much to the

disgust of some employers. They had elaborate rules, rites, and rituals, some of which were designed as window dressing to appease potentially destructive mistrust by the powerful. Such associations carried within themselves the implicit notion that an escape from the dominant order was possible.

In 1875 a quarter and in 1890 a third of all miners belonged to union-organized insurance schemes.[79] There existed a plethora of schemes; their growth was particularly strong in the second half of the century, and miners often participated in more than one. The West Riding Miners' Permanent Relief Fund Society is one example. Established in the form of a movement in Northumberland in 1862, it expanded to other regions before its official foundation in January 1877. This type of movement, initially supported by employers, was funded through member subscriptions and donations. Its aim was narrower than that of the Friendly Societies: to assist families of dead workers and to support those injured by work accidents. The West Riding society expanded from 3,941 members in 1878 to 19,993 members in a decade. However, in 1890 the proprietors organized a competing society. This resulted in a decline in membership of the former and, much later, proprietors refused to collect fees for it. "The logic which underlay the proprietors' decision was the idea that the more money an injured worker received, the less likely he was to return to work."[80] They sought to remove the autonomy to make decisions that workers, able to choose between adequately paid convalescence and work, had eked out.

Whatever the inadequacies of the levels of compensation provided through these schemes, whether run by employer, employee, or insurance companies, their growth was spectacular. "In 1875, more than 40% of all English coal miners were insured. . . . In 1880, 60% were thus insured, and five years later more than 85% were."[81]

In the 1880s and 1890s, rates of fatal accidents in the sector declined.[82] Victims, or at least those who had joined schemes, were receiving greatly improved levels of compensation. Yet the issue of accidents became more important in the public eye. This seeming paradox was inextricably linked to the development—accompanied by the legalization of unions, the establishment of conciliation mechanisms, the extension of suffrage, and the entry into national parliamentary politics—of an increasingly organized and strong trade union movement. Some sectors of industrial capital felt threatened as the cost of accidents started to rise, particularly as jurisprudence altered and juries, reflecting the new conjuncture, started awarding important damages to some of the injured.[83] In addition, the compensation schemes became sources of conflict, with employer-run schemes being contested by workers and work-

er-run schemes being contested by employers. The inability of small schemes to cope with disasters and the plight of the uninsured were further matters of concern. In the climate that prevailed from the 1870s, the increased conflict and litigation exposed accidents, and the industrial system, to the public eye. Each glimpse added to moral outrage, and this was increasingly expressed through political channels.

In the rest of Europe conflicts over industrialization varied in intensity, shape, and timing, but the basic issues seem, from the point of view of accidents, to have been similar. In Germany, Bismarck introduced in 1884 the first comprehensive state intervention in the area we now call social security: accident compensation, which served as a central point of reference in British discussion.[84] Under this initiative state-supervised employers' insurers were responsible for paying legally required benefits, and workers lost most rights to further damages. An 1897 British commentary provides a politically focused overview of the Bismarckian system:

> In the inevitable fluctuations of modern industrial life, [it] will afford to all those in need of assistance a welcome aid, and its further development cannot fail to exercise a great and salutory influence on the economical and social conditions of the working people. . . . the circumstances which tend to disturb the good relations between employers and employed are everywhere much the same, the hope is natural and well justified that the consideration and forethought which the German labourers owe to the beneficent initiative of their magnanimous Emperor, and to the ready sacrifice of employers, will find an echo in other civilised countries for the welfare of the human race and the consolidation of social peace and concord.[85]

The Bismarckian model was claimed to have swept a socially disrupted Europe "like a wave."[86] In Britain the "wave" arrived in 1897 when the Workmen's Compensation Act was passed. Workers no longer had to prove employer fault to gain minimum damages and employers would be liable for further damages where negligence could be proven in court action.[87] For the statesman Joseph Chamberlain, the bill's main objective was to avoid litigation. For Walker, it constituted a historic rupture, being "the pioneer system of social security in Britain and . . . the first major departure from the long-standing common-law principle that liability must be based on fault."[88]

The act constituted a political compromise, successful because it satisfied fully neither all employers nor unions and friendly societies. The only significant sources of opposition to the passage of the act were the latter bodies. Friendly societies can be seen as protecting themselves from competing schemes. Union opposition was of a different nature, claiming that "insurance would lessen concern for safety on the part of employers."[89]

Compensation in Perspective

This discussion permits us to see that state intervention into accident compensation, whether of the German or British form, permits the mediation of a number of social conflicts:

1. At an economic level, by being an insurance scheme, it reduces the risk both to business of exceptional and costly accidents and to injured workers and their families of being left destitute.
2. At a social and political level, it reduces the visibility of accidents to the public by reducing legal battles over compensation and, because it increases the success rate of workers in obtaining compensation, it reduces a source of animosity between workers and employers.
3. At a political level, it reduces worker contest of employer-administered schemes and employer contest of worker-administered schemes.

At a more general level, it would reduce what appeared to be a growing area of worker dissatisfaction and the labor movement's organization and power and it would do so without impinging on the organization of employer power within the workplace. This would be done by building up a system of standardized payouts for technically standardized injuries, which would be defined in a manner removed from the power of actors in the workplace. In making such a definition, the institution would define itself as "neutral." Through having this definition accepted, workers' compensation schemes would serve a further political function to:

4. Promote social peace.

CONCLUSIONS

The Management of Safety and Compensation

British coal mining constitutes a historically important and therefore reasonably well-documented case. Its examination has permitted the building of a number of insights into the origins and roles of modern accident prevention and compensation institutions. The institutional structures of prevention and compensation adopted in British mining have been adopted elsewhere, everywhere these can be hypothesized to exercise similar functions, and where conflicts occur, to inject these with structural similarities.

A widespread adoption of these institutional structures occurred in the West. Heclo presents a table in which accident insurance guaranteed by law exists in all of the 24 countries included,[90] and it was the pioneer form of social security in 20 of these. In a 1923 report the International Labour Office concluded that, in all of the countries examined, the factory inspectorate "in all its diversity seems to have taken the same paths."[91]

Various studies confirm that the tensions seen as having given rise to the British institutional responses were not confined to that country. They point toward the emergence of compensation institutions that fulfill at least some of those functions identified on the basis of British evidence in U.S. coal mines,[92] in the states of Washington and New York,[93] through private initiatives by large U.S. employers,[94] and in Belgium.[95] French reflection has highlighted the importance of compensation for the building of social peace, for the conservation of employer power, and, in a monumental work by Ewald, as reflecting a profound change in the human being's relation to self and through this laying the basis for a new form of society and its state—the welfare state.[96]

Researchers appear to have been far less interested in prevention, but in both France in the 1860s[97] and in the United States in the 1900s,[98] we learn of employers who resort to safety engineering and internal regulations in an effort to ward off threatened state intervention to reduce costs and potential sources of conflict. In the latter country, insurance companies can be observed acting almost as private regulatory bodies, reducing the premiums of those firms that follow certain standard safety procedures.[99] Graebner's study of the origins and functioning of the U.S. Bureau of Mines provides further confirmation in the field of prevention of two notions developed in this chapter: first, that structurally similar forces operate in industrial nations, and as a result a limited range of solutions to the problem of accidents are available for adoption; and second, that changes in relationships between these forces lead to reforms in these solutions.[100]

Both prevention and compensation originally treated with silence and then through conflict henceforth will be treated through rules and regulations. The (Weberian) bureaucracy replaces the naked consequences of (Marxian) class conflict.

Union movement and employers, through accidents, become integrated into a set of political institutions that seek to transform political and industrial problems into administrative ones. Subsequent to the passing of the 1897 British Compensation Act, and counter to employer expectations, litigation became more frequent. This led to a concrete institutional result: the 1906 Workers' Compensation Act, universally seen as an important victory for the workers' movement. The inspection

system in the British coal mines proved to be such a point of conflict that miners were granted the statutory right to appoint Workmen's Inspectors to ensure mine safety.[101] Workers and employers now struggle within and for the alteration of an institutional framework. As the locus of conflict is displaced, social peace is produced.[102]

At the social level, traditional notions of truth and justice used by workers to oppose employers' ideas about safety and to support their own definitions are replaced when technical safety devices and later legislative standards emerge. These seek to reduce all judgments on safety to criteria of "fact" and counterpose these to criteria of "value." This forms a basis for work discipline. The accident is desocialized, removed by these instruments from the social context of its production. Besides undermining worker notions of truth and justice, the standards approach has been identified as producing other specific effects:

1. the effective investment effect
2. the ineffective investment effect
3. the noninvestment effect
4. the investment inequality effect
5. the new accident effect

The criterion used to measure efficiency is not one of performance measured in terms of reduced accident rates, but rather of performance measured in terms of conformity to a technically defined standard. In the area of compensation human life and limbs are reduced to cash sums calculated by reference to standardized legally or insurer-determined tables. Actuarial calculations induce many employers to see accidents and their compensation as a normal part of business.

Intermediaries are made responsible for the determination of and the policing of safety standards, and for the calculation and the overseeing of compensation claims and payments. Inspectors and certifying surgeons employed by the state[103] and industrial nurses[104] and engineers employed by industry are added to by recruits from new professions, such as industrial medicine[105] and safety engineering,[106] that form to play this interventionist role.

In both prevention and compensation, a new power is born, a new site of conflict resolution, and, in turn, of possible conflict is built: its symbol is the standard.

The Visibility and Invisibility of Accidents

The birth of industrial society meant that the silence surrounding accidents and their causal association with sin were replaced as "identi-

fiable superiors' actions" came to be seen as producing death. Such identification formed the basis of moral outrage that spilled out of workplaces and into society. Increasingly, the workplace began to be seen as producing death. This was occurring in spite of the fact that public health was increasing life span and, in so doing, partly conquering the problem of death. The rise of industrial society was also accompanied by increasing secularization; this resulted in the "after life" being rendered relatively less important than "this life." This conjuncture led to industrial capitalism's search for profit being seen as killing humanity's newfound control over life. In a way, perhaps more fundamental than any other, industrial capitalism was visibly undermining itself in terms of a culture it had played a part in producing.

Institutions born to treat prevention and compensation were formed in the space created between the production of capitalist profit and the production of death in a culture that was increasingly giving value to life. It should be of little surprise that efforts to channel prevention and compensation be directed toward hiding accidents from public view. Prevention, in British coal mines, was first sought by investing far more into suppressing the technical sources of rare and spectacular disasters than into the less visible, but eventually far more murderous, nondisaster accidents. In the area of compensation, there was a constant employer preoccupation with the visible destitution caused by accidents and a desire, through recompense, to reduce that visibility.

Industrial death shall be produced invisibly. Nascent conflicts shall be resolved institutionally. "The seeds of progress sown," a triumphant industrial capitalism, and the science that serves it, celebrates its victory in a manner designed to be visible to all. In the United States, science, society, and safety were fused in the First National Safety Exhibition held in New York in 1907, under the auspices of the American Institute of Social Science.[107] A year earlier, the French president had referred to the opening of the Museum for the Prevention of Work Accidents and Industrial Hygiene as a crystallization of a consensual political vision; he called it a "work of science, peace and love."[108]

NOTES

1. R. Samuel. 1977. The workshop of the world. *History Workshop Journal* 3:6–72 (p. 13); and M. Ellerkamp and B. Jungmann. 1983. Le travail et la santé: La vie des ouvrières d'une usine textile de Breme entre 1888 et 1914. *Le Mouvement Social* 124:111–130, are among the authors who lament the absence of historical studies on the general theme of health and work, which includes industrial accidents. The most important effort to fill this gap is the journal *Histoire des Accidents du Travail,* edited by J.-P. Hesse at l'Universite de Nantes.

2. L. Mumford. 1950. *Technique et Civilisation.* Paris, Seuil. A lucidly written book about this transformation.
3. J. U. Nef. 1932. *The Rise of the British Coal Industry,* vol. 1, p. 416. London: Routledge and Sons. Discusses the case of the Jadson brothers who did this in 1583.
4. Nef, 1932, vol. 1, pp. 413–448, discusses the uneven transformation of the sector, observing that Elizabeth's reign marked the beginning of a new era.
5. This statement merits, in itself, an essay. In the preindustrial era (and before financial incentives became effective), the extension of the working day beyond the physical capacities of workers constituted the major method of managing free labor. With the rise of industrialization, design and execution were separated and with this the organizational level became dominant.
6. E. Quinot. 1979. Le phenomène accident. *Le Travail Humain* 42(1):87–104. This article cites Martin in Voltaire's work *Candide* as reflecting the spirit of the times: "Let's work without thinking; it is the only way to make life bearable" (p. 94).
7. Paracelsus, 1557, cited in Quinot, 1979, p. 87. Agricola. 1546. *De Re Metallica* cited in M. Valentin. 1978. *Travail des Hommes et Savants Oublies,* p. 21. Paris: Docis, attributes accidents to "ghostly creatures."
8. Quinot, 1979.
9. P. Ricoeur. 1960. *Philosophie de la Volonte.* Paris: Aubier, cited in Quinot 1979, p. 97. M. Douglas and A. Wildavsky. 1982. *Risk and Culture,* pp. 29–32. Berkeley and Los Angeles: University of California Press. This book also discuss the cultural question.
10. Nef, 1932, vol. 2, p. 173.
11. B. Moore, Jr. 1978. *Injustice: The Social Bases of Obedience and Revolt,* pp. 458–459, 471. White Plains, N.Y.: Sharpe, cited in C. Gersuny. 1981. *Work Hazards and Industrial Conflict,* p. 8. Hanover, NH: University Press of New England (my emphasis).
12. Nef, 1932, vol. 2, p. 172.
13. J. Benson. 1980. *British Coalminers in the Nineteenth Century: A Social History,* pp. 6–7. Dublin: Gill and Macmillan. By 1913 the labor force was over 1,127,000 and production 28 times its 1800 level.
14. D. Douglass. 1977. The Durham pitman, and, Pit talk in County Durham. in R. Samuel (ed.). 1977. *Miners, Quarrymen and Saltworkers,* pp. 207–295, 297–348. London: Routledge and Kegan Paul (pp. 334–335).
15. Samuel, 1977, p. 60.
16. E. P. Thompson. 1963. *The Making of the English Working Class* (1968 edition). Harmondsworth, Penguin. This places Chartism in context.
17. P. Hair. 1968. Mortality from violence in British coal mines, 1800–50. *The Economic History Review* (2nd series) 21(3):545–561 (p. 555).
18. Children's Employment Commission 1842. *Reports from Commissioners,* vol. 1, *Parliamentary Papers,* p. 145. London: Her Majesty's Stationery Office.
19. Children's Employment Commission 1842, vol. 1, p. 144. Emphasis in original.
20. In France we find a similar general polarization. P. Bance. 1976. *Le Syndicalisme Ouvrier Français dans la Génèse du Droit du Travail (1876–1902).* Ph.D. thesis: Université de Paris I, comments on the apathy with which workers and especially unions at the end of last century greeted the accident theme; and J. Rancière. 1981. *La Nuit des Prolétaires.* Paris: Fayard, relates the search for a society of free workers that was undertaken in the middle of last century. One key issue was to escape the constraints of a society in which apathetic workers were the norm.
21. E. J. Hobsbawm. 1964. *Labouring Men,* pp. 186–190. London: Weidenfeld and Nicholson.
22. Children's Employment Commission, 1842, vol. 2, pp. 169–70.

23. Children's Employment Commission, 1842, vol. 2, p. 172.
24. Children's Employment Commission, 1842, vol. 2, p. 168.
25. Children's Employment Commission, 1842, vol. 1, p. 136.
26. Children's Employment Commission, 1842, vol. 1, p. 143.
27. Children's Employment Commission, 1842, vol. 1, p. 144.
28. Children's Employment Commission, 1842, vol. 1, p. 143.
29. Children's Employment Commission, 1842, vol. 2, pp. 169–170.
30. Children's Employment Commission, 1842, vol. 2, p. 169.
31. Children's Employment Commission, 1842, vol. 2, p. 143, part 1 to Appendix, citing Dr. Mitchell's report on South Durham.
32. Hair, 1968, provides the statistical base and information on employer orientations essential to the argument to be developed.
33. S. G. Checkland. 1964. *The Rise of Industrial Society in England 1815–1885,* p. 158. London and Harlow: Longmans Green.
34. Valentin, 1978, p. 176.
35. M. Berg. 1980. *The Machinery Question and the Making of Political Economy 1815–1848,* pp. 146ff. Cambridge, Cambridge University Press.
36. Select Committee on Accidents in Mines. 1835. *Report from the Select Committee on Accidents in Mines. Parliamentary Papers,* pp. 221–223. London: Her Majesty's Stationery Office.
37. H. H. Holmes. 1816. *A Treatise on the Coal Mines of Durham and Northumberland.* London: Baldwin, Craddock and Joy. Holmes pointed out at this very early date that methane could explode if it penetrated the gauze too quickly and if the gauze became detached from the lamp, thus exposing the flame; falling pieces of coal, an accumulation of dust on the gauze, or coal dust particles igniting on contact with the gauze constituted further risks. This was discussed in D. Albury and J. Schwartz. 1982. *Partial Progress—the Politics of Science and Technology,* pp. 16–17. London: Pluto.
38. Children's Employment Commission 1842, vol. 1, p. 140.
39. J. Rule. 1981. *The Experience of Labour in Eighteenth Century Industry,* p. 86. London: Croom Helm.
40. L. Quere. 1982. *Des Miroirs Équivoques.* Paris: Aubier Montaigne.
41. E. P. Thompson. 1967. Time, work-discipline and industrial capitalism. *Past and Present* 38:56–97.
42. Rule, 1981, p. 86. R. G. Neville. 1979. Accidents du travail, sécuritè dans la mine, maladies professionelles et indemnisation des accidents dans les regions minières de Yorkshire 1881–1926. *Histoire des Accidents du Travail* 7:45–81, reports that the percentage of accidental deaths from roof falls in Yorkshire increased from over 50% in 1881 to 56% in 1894 and 59% in 1921 (p. 55).
43. B. L. Hutchings and L. Harrison. 1903. *A History of Factory Legislation,* p. 39. Westminster: P. S. King and Son.
44. W. G. Carson. 1979. The conventionalisation of early factory crime. *International Journal for the Sociology of Law* 7:37–60 (p. 43).
45. J. Choi. 1984. The English Ten-Hours Act: Official knowledge and the collective interest of the ruling class. *Politics and Society* 13(4):455–478 (p. 461).
46. *The Times,* May 18, 1838, cited in Carson, 1979, p. 45.
47. J. A. Schmiechen. 1975. State reform and the local economy: An aspect of industrialisation in late Victorian and Edwardian London. *The Economic History Review* (2nd series), 28:413–428. Carson, 1979, p. 44, refers to an article in which "factory legislation was seen in this period as having potentially important effects on the competitive structure of the textile industry."

48. See P. W. J. Bartrip and S. B. Burman. 1983. *The Wounded Soldiers of Industry—Industrial Compensation Policy 1833–1897*, pp. 83–96. Oxford: Clarendon Press, for a treatment of early measures in the coal sector. See H. Pelling. 1963. *A History of British Trade Unionism*, 2nd ed., p. 38. London and Basingstoke: Macmillan, for a treatment of the role of the National Miners' Association in the 1860 Act.
49. Hutchings and Harrison, 1903, pp. 114ff, discuss this move. Factory inspectorate reports quantify that accidents increased 21% in a semester. K. Marx. 1894. *Le Capital-Livre III* (1976 edition), p. 101. Paris: Editions Sociales. See Bartrip and Burman, 1983, pp. 63–66, on the "fencing controversy."
50. Schmiechen, 1975, using data from a later period, shows that the enforcement of the laws led to a 40% increase in the unregulated male-tailoring workshop trade in Kensington between 1903 and 1907. See also the debate provoked by Schmiechen in J. Morris. 1982. State reform and the local economy. *Economic History Review* (2nd series) 35(2):292–300, and Schmiechen's reply, pp. 301–305.
51. See Edmund Potter quoted in H. Perkin. 1963. *The Origins of Modern English Society 1780–1880*, p. 450. London: Routledge and Kegan Paul (emphasis in text).
52. P. Bartrip and P. Fenn. 1980. The Administration of Safety: The enforcement policy of the early factory inspectorate 1844–1864. *Public Administration* 58(1):87–102.
53. Pelling, 1963, pp. 38, 71. (I have used Bartrip and Burman's spelling of Macdonald's name.)
54. A. L. Friedmann. 1977. *Industry and Labour*, pp. 60ff. London and Basingstoke: Macmillan, discusses developments relevant to labor issues.
55. By 1873 the two movements had over 100,000 members each. See Pelling, 1973, p. 72.
56. Le Comte de Paris. 1873. *De la Situation des Ouvriers en Angleterre—Mémoire Presente à la Commission d'Enquête sur les Conditions de Travail*. Paris: Michel Levy Fres. This provides an interesting and detached account of this law and its measures regarding explosions, winding machinery, haulage, boilers, and manager training.
57. The parliamentary discussion around this bill shows worker representatives' complaints about such delays. See Hansard's Parliamentary Debates. 1872, vol. 209, p. 231ff, and vol. 211, p. 715.
58. Bartrip and Burman, 1983, pp. 67–68, see this as changing little from the 1844 Act.
59. R. Boudon. 1977. *Effets Pervers et Ordre Social*. Paris: Presses Universitaires de France.
60. Hutchins and Harrison 1903; and Carson, 1979. A. E. Peacock. 1984. The successful prosecution of the factory acts, 1833–55. *Economic History Review* (2nd series), 37(2):197–210. See also the comments by P. Bartrip. 1985. Success or failure? The prosecution of the early factory acts. *Economic History Review* (2nd series), 33(3):423–427; and in the same issue C. Nardinelli. 1985. The successful prosecution of the factory acts: A suggested explanation, pp. 428–430, and Peacock's reply, pp. 431–436.
61. Neville, 1979, pp. 62–63, refers to studies that show inspectors attempting to put the blame for accidents on dead miners, thus exonerating owners. It seems that an unfavorable judgment of the inspectorate's neutrality can also be applied beyond British shores: see P. Cassard and P. Hesse. 1980. L'inspection du travail et les accidents en Loire-Inferieure de 1894 a 1904. *Histoire des Accidents du Travail* 8:33–42; and R. Asher. 1986. Industrial safety and labor relations in the United States, 1865–1917, in C. Stephenson and R. Asher (eds.), 1986. *Life and Labor: Dimensions of American Working Class History*, pp. 115–130. Albany: State University of New York Press.
62. D. Eva and R. Oswald. 1981. *Health and Safety at Work*, p. 29. London: Pan. Neville, 1979, p. 64.
63. Bartrip and Burman, 1983.

64. In 1890 only 8% of industrial workers were unionized. See Friedmann, 1977, p. 65.
65. The first point about the availability of technology has been illustrated by taking the case of the Davy lamp. To illustrate the second point on politics: In the second half of the century the increase in the importance of piecework was associated with opposition to propping, since time spent at this activity directly reduced piece rate earnings. In the absence of controls on piecework and faced with declining propping practices a category of worker—timberman—eventually came into being to perform this task. See Samuel, 1977, p. 63. In spite of the high proportion of accidents historically associated with cave-ins, these do not generally result in large-scale politically important accidents, and in spite of technology being available for their prevention, it is only in the political climate of 1887 (which is explained later in the text) that a law is passed to effectively reduce related accidents by fixing a maximum distance between certain supports. The "most significant reduction in the accident rate from falls of ground followed immediately after the 1887 Act." Royal Commission on Safety in Coal Mines. 1938. London: His Majesty's Stationery Office. p. 248.
66. P. Aries. 1974. *Western Attitudes towards Death*, pp. 55–56. Baltimore, MD: Johns Hopkins University Press.
67. J. M. Roberts. 1976. *The Pelican History of the World*, pp. 637ff. Harmondsworth: Pelican (1980 edition).
68. Hair, 1968, p. 549.
69. E. J. Hobsbawm. 1968. *Industry and Empire*, pp. 94–95. Harmondsworth: Penguin.
70. J. Benson. 1979. L'Indemnisation pour accidents du travail accordee aux mineurs anglais et leurs ayants—droit 1860–1897. *Histoire des Accidents du Travail* 7:1–43 (p. 25). In addition, Benson states that the money raised through such appeals depended on a variety of factors: the participation of prominent citizens, other recent appeals, and the isolation of the mine.
71. J. Benson. 1974. Colliery disaster funds, 1860–1897. *International Review of Social History* 19(1):71–85 (p. 84).
72. Benson, 1979, p. 14.
73. Neville, 1979, p. 73.
74. A. Wilson and H. Levy. 1939. *Workers Compensation* (in two volumes). London: Oxford University Press, cited in Benson 1979, p. 18. See also Bartrip and Burman, 1983, Chapter 6.
75. Benson, 1979, p. 8.
76. G. Howell. 1902. *Labour Legislation, Labour Movements and Labour Leaders*. London: Fisher Unwin, cited in Benson, 1979, p. 28.
77. Thompson, 1963, p. 460, estimates the number of Friendly Society members at 925,429 in 1815. T. Tholfsen. 1976. *Working Class Radicalism in Mid-Victorian England*, p. 288. London: Croom Helm, estimates 1872 membership at 4,000,000.
78. Alain Cottereau discusses these associations in the French context. He takes pains to point out that a real debate existed as to whether production associations were forms of self-exploitation or instruments of resistance and contest. Refer to the introduction in D. Poulot. 1980. *Le Sublime*, p. 91. Paris: Maspero (original 1870); see also Tholfsen, 1976, p. 293ff.
79. Benson, 1979, p. 31.
80. Neville, 1979, p. 72.
81. Benson, 1979, p. 32.
82. Neville, 1979, p. 47.
83. Benson, 1979, p. 34.

84. Bartrip and Burman, 1983, show that Chamberlain referred to it in the election campaign that commenced in 1894 (p. 199), his original model being the German one (p. 205), "A Compensation Act for Workmen, irrespective of accident cause" (p. 199). Macdonald opposed the idea on the grounds that it would not force employers to engage in safety (p. 143). The Social Science Association referred to a scheme for German miners, in operation since 1865. See pp. 139–145 for the debate.
85. Anon. 1897. Employers' liability: The German system. *Journal of the Department of Labour* (New Zealand), pp. 120–140 (p. 140). (Reprinted from the *London Chronicle* in an obvious desire to influence New Zealand developments.)
86. Anon. 1898. *Journal of the Department of Labour* (New Zealand), p. 76. Bismarck's desire "to prove to the socialists that his programme was a positive one" is quoted here.
87. Bartrip and Burman, 1983, pp. 205–206.
88. A. Walker. 1981. The industrial preference in state compensation for industrial injury and disease. *Social Policy and Administration* 15(1):54–71 (p. 55).
89. Ibid. See also Bance, 1976, who notes two types of opposition to a similar French law of 1898: one from anarchist revolutionaries, for whom the provision would serve to postpone the revolution, the other from those who, seeing the state as their enemy, wanted friendly society or independent provisions. A. L. Stinchcombe. 1985. The functional theory of social insurance. *Politics and Society* 14(4):411–430, attributes to the strength of friendly society interests in Britain the option for a noncontributory scheme. Bartrip and Burman, 1983, p. 221, assess the British solution as a political compromise.
90. H. Heclo. 1974. *Modern Social Politics in Britain and Sweden*, p. 10. New Haven: Yale University Press. A. J. Heidenheimer, H. Heclo, and C. T. Adams. 1975. *Comparative Public Policy*, p. 189. London and Basingstoke: Macmillan, provides the following sample of dates of introduction: Denmark, 1898; France, 1898; Italy, 1898; Sweden, 1901; Netherlands, 1901; United States, 1908; Greece, 1914.
91. International Labour Office. 1923. *Factory Inspection*, p. 6. Geneva: International Labour Office.
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95. M. Sojcher-Rousselle. 1979. *Droit de la Sécurité et de la Santé de l'Homme au Travail*. Brussels: Bruylant.
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97. J. Le Goff. 1985. *Du Silence à la Parole: Droit du Travail, Société, État (1830–1985)*, pp. 82–83. Quimperle and Quimper: Calligrammes and La Digitale. Valentin, 1978, pp. 227–232.
98. R. De Reamer. 1980. *Modern Safety and Health Technology*, pp. 6–7. New York: John Wiley. Berman, 1978, pp. 10–15.
99. F. E. Bird and G. L. Germain. 1966. *Damage Control*, pp. 17–18. New York: American Management Association: "It is reasonably accurate to say that these early compensation laws so increased the cost of occupational injuries that employers were forced to find methods of reducing the injuries. . . . With insurance rates based on injury experience and costs, it was natural that the newly introduced industrial safety man, following management's specific request, directed his attention to the injury associated accident."
100. Graebner, 1976. For a more theoretical discussion about French norms see Ewald, 1986.
101. Robens (Lord). 1972. *Safety and Health at Work*, p. 19. London: Her Majesty's Stationery Office. Comte de Paris, 1873. See also D. Reid. 1981. The role of mine safety in the development of working class consciousness and organization: The case of the Aubin Coal Basin, 1867–1914. *French Historical Studies* 12:98–119.
102. P.-J. Hesse. 1982. *Premier Congrès de l'Hygiéne des Travailleurs et des Ateliers* (organise en 1904 par la CGT). Paris: l'Emancipatrice. This is a summary of the work in *Histoire des Accidents du Travail*, 12, in the section "fiches de lecture." We see that subsequent to a diagnosis of problems in the workplace, a series of demands are made; in their majority these relate to state action and the necessity for its reinforcement. Although this is a first conference on the matter and demands will continue to grow, we can see how they are now channeled toward institutional solutions. For the United States, see Graebner, 1976, p. 72. "Whereas nineteenth century coal-mining safety laws had been the product of an operator-miner struggle within the legislature, twentieth century legislation was usually developed by a commission of operators, miners and other officials." Graebner later observes that, against a background of a variety of factors, "interest in safety matters . . . declined considerably after 1912" in national union conventions (p. 130).
103. International Labour Organisation. 1968. *The Role of Medical Inspection of Labour*, p. 6. Geneva: International Labour Organisation. In Britain in 1844 certifying surgeons were charged with checking the age and physical fitness of children. The first Medical Inspector of Factories is appointed in 1898.
104. M. Hamilton. 1977. How others see us: The occupational health nurse's view of the safety officer. *Occupational Health* June, 290–294. The first full-time industrial nurse was appointed in England in 1878 by Colmans at Carrow.
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2

From Peace to Rupture

Development and Crisis of Modern Solutions

INTRODUCTION

The "work of social peace," as these institutions—both public and private—have been called, deal with prevention and compensation. Throughout the twentieth century they would increase the scope of their actions, their membership would rise, and their focus would become increasingly varied.

For the critics these institutions were inadequate in both their prevention and compensation activities. For the supporters, miracles were being worked. From the end of World War I until the end of the 1960s, a general climate of peace and harmony surrounded the question of accidents in the advanced industrial nations. This climate constitutes a measure of the political success of prevention and compensation institutions. However, the success of the prevention institutions in achieving their stated social goal was less clear: in general terms, excluding wartime or depression hiccups, accident rates declined in the advanced nations from the 1920s until the 1950s, and then stabilized or started rising in some countries until the end of the 1960s.

During the first two thirds of this century, numerous changes, insignificant for some authors and fundamental for others, occurred subsequent to each institution's foundation. As the last third of this century was entered, practices grounded in the nineteenth century, as well as those emerging and seeking dominance for the twenty-first, could be found side by side and frequently in conflict. Beyond this conflict between past and future was another: one that could be called ideological and which manifested itself in contradictory demands, from both internal and external sources, on institutions. Such demands frequently op-

pose profits and safety, in the case of prevention, or profits and adequate indemnification, in the case of compensation.

Definition of Lines of Research

Against this background, two general lines of research suggest themselves: to understand the growth of these institutions and to understand the nature of conflict within and between them. This chapter will necessarily concentrate on a part of the picture in order to illuminate professional and state interventions that are crucial for the understanding of the institutions' past, their current activities, and their future.

Institutional Interventions

The notion of "safety and compensation institutions" is used to encompass both public and private sector interventions that take on an organized form. The seeds that produced safety professionals were sown in the beginning of the last century, and some professionals started organizing into associations from the beginning of this century to intervene in the workplace in the name of greater industrial safety and the reduction of the consequences of industrial injury. The private sector and the state provide markets for technicians, doctors, nurses, ergonomists, and others who intervene in the workplace. Academic subdisciplines and disciplines are created and developed to deal with accidents. The term "institution" designates discrete state, insurance, and professional bodies that intervene through their agents in a specialized manner between employer and employee regarding industrial accidents. Such a term is chosen over the relatively undifferentiated term "compensation-safety apparatus," developed in Berman's pathfinding study, precisely to permit a degree of complexity and internal differentiation to be perceived within diverse areas of activity.[1] Three professions which are considered to represent distinct institutions have been selected for in-depth treatment: safety engineering, industrial medicine, and ergonomics (frequently called human factors engineering in the United States). The selection was made both because of the widely recognized importance of these groups and because of the conflicts their actions reveal; such conflicts appear to be pregnant with consequences for the future management of industrial accidents. Industrial psychology's role is a more diffuse one and, for this reason, the discipline will be investigated in less depth. In the arena of state action, both compensation and prevention institutions will be examined. To provide broad insights it is important to go beyond a narrow focus on the country for

which the best data are available; therefore, in addition to the United States, France and Britain will be focused on.

To understand these institutions, we will begin with an abstract examination of institutional growth through the concept of demand.

DEMAND

Institutions, of whatever forms, respond to demands from two distinct sources: one internal and the other external. External demands can emanate from sectors as diverse as employers, governments, unions, and the "general public"; conflicting actors can be led to make similar demands and demands can change over time. Changes in demand, both internal and external, are expressions of changing relationships within and between the spheres of culture, interests, and information. In Chapter 1 we saw how the Davy lamp was produced in 1815 after a group of mine owners commissioned Sir Humphrey Davy to put his talents to work and provide a mechanism capable of limiting the risks of gas explosions. The motives of these employers, frequently represented as humanitarian or "modern," have been analyzed more recently by Albury and Schwartz as largely related to economic interests based on a desire to reduce the costs of disasters and to mine coal in inaccessible seams.[2]

Early reports by British chief factory inspectors frequently requested greater powers and staffing. When such an internally generated demand was presented in a favorable external political context (such as that found subsequent to major accidents), resources could be voted by Parliament to satisfy it. In the case of the Davy lamp, demand for the safety intervention may be characterized as being primarily economic and secondarily as political.

Economic, Political, and Social Demands

If the origins of demand can be distinguished as being economic and political in nature, where does this leave "humanitarian efforts," often presented as a simple request that accidents be reduced? Such demands shall be referred to as social, and can be seen, at least in part, as reflecting cultural values relating to justice. Demands, when met by institutions, generate investments of resources. Investment, however, does not guarantee success. Political, economic, and social criteria can all be used to decide whether a demand is satisfied. As there is no reason to presuppose that any one intervention made in the name of accident

prevention will successfully fulfill any of these demands, there is even less reason to imagine that such intervention will simultaneously fulfill all such demands.

Institutional Responses to Contradictory Demands

Demands made on a safety institution may be contradictory. Organizations, of whatever type, have three classic modes of response to contradictory demands: scission, integration, and submission. *Scission* is the response whereby an organization, faced with demands perceived as contradictory, is unable to form or maintain a unified response and as a result divides. *Submission* occurs when an organization responds in a unified fashion to one set of demands even if this means that it ignores others. *Integration* occurs when the organization responds to sets of conflicting demands.

In responding to new external demands, or in attempting to internally produce new sources of demand, institutions inevitably experience tensions. Such is the price of growth, particularly in a changing world. A general increase in demand for services may reflect differently on distinct institutions. Those which do not respond to external demand may lose membership, stagnate, or close. The dynamism of the American Society of Safety Engineers which grew by 50 percent between 1964 and 1973 contrasts with the relative stagnation of the American Occupational Medicine Association which lost 2 percent of its membership in the same period.[3] Both avoided the fate of the American Museum of Safety which transformed itself into the World Safety Institute before disappearing.[4] From such simple figures it can be deduced that the second and third organizations were less successful in responding to and perhaps producing (through self-promotion or other means) external demands than the first. This, as has been stated in more general terms above, tells us nothing about the success of an organization or institution in satisfying demands. In other words: we cannot make the common mistake of assuming that an increase in the numbers of (say) safety engineers in response to economic demands will lead to the satisfying of social demands as expressed in the reduction of injuries. Continued investment in an institution can be seen as a sign that it has met with a certain success; however, the nature of this—economic, political, or social—can only be determined through research on a case-by-case basis. Furthermore, the success of one institution may limit the growth of another. Ashford states that the United States had one government safety inspector for every 20,000 workers, Great Britain one for every 12,000, and Finland one for every 4,400.[5] However, the United States

principally relies on a private sector model to achieve industrial safety, and it is hard to discern the meaning of such figures without putting them in context. In this chapter I will not attempt a comparative analysis of differential institutional growth rates[6]; it appears to me that the major interests are in certain features, tensions, and trends, both specific and general, to be found among the institutions to be examined.

The concept of "demand" is a tool designed to foster an understanding of two phenomena: the growth of certain institutions and debates and their attempts at reorganization; many such attempts can be seen as efforts to find new orientations in order to attract investments from external sources. Partly through the use of this concept and partly through the observation that institutions integrate or submit to demands in an effort to attract investments necessary to ensure survival and growth, or split as a consequence, I believe that it is possible to arrive at an understanding of both the peaceful and apparently undramatic growth of institutions in the industrially advanced countries during most of this century (once typically rapid postfoundation growth and other exceptions are discounted) and the rupture of this peace toward the end of the 1960s and the beginning of the 1970s. From the rupture onward new demands are expressed, new conceptualizations of intervention are formulated, and systematic sociological attempts to investigate accidents begin.

The Rupture: A System Response to Contradictory Demands

What I call "the rupture" occurred in a number of industrial nations. It brought the conflicts about accidents into the open and precipitated inquiries and legislation. While the divisions and responses differed from one country to another, the tensions built up within institutions in the advanced industrial nations appeared to be of similar natures. What the rupture appeared to question, in effect, were not distinct national systems of dealing with accidents, but the key institutional arrangements—which share common structural features in all advanced industrial societies—for dealing with the phenomenon.

Interlude: The Shape Taken by Interventions

The shape any system of management eventually takes is linked to the resources available at the time of its birth, and safety management is no exception. An example is engineering: the work of general engineering theorists such as Poulot in France, Whitworth in England, and Taylor in the United States was necessary to provide the basic analytical re-

sources for the invention of systematic safety engineering by Heinrich.[7] Reflecting a different dimension, the development of safety strategies and compensation as primarily private sector activities in the United States have been analyzed in terms of political processes, as reflecting both the political incapacity of those favoring state control to impose their model and the strength of opposition to such a model.

This discussion should be kept in mind as we examine safety engineering, industrial health, psychology, ergonomics, state-managed compensation, and subsequently prevention. The role of the workers' movement will be discussed before analyzing the rupture.

SAFETY PROFESSIONS

Safety Engineering: Integrated Tensions

Background

Engineering is one of the valves in the heart of industrial capitalism. Investment in what Marx called the "forces of production" serves to raise productivity. From Davy's safety lamp to Westinghouse's air brake for trains, engineers have invented specialized devices that, in the name of accident prevention, can help increase productivity.

The rise of engineering in the field of industrial safety is intimately linked to its rise in importance to industrial capitalism. Its growth is often identified with social progress. A case in point is Denis Poulot,[8] a French industrialist and radical republican who campaigned from 1864 for engineers to shift their activities from war to industrial manufacture. In a Saint-Simonean-like vision, he believed greater investment in machines would develop precision products, increase productivity, and ensure greater employer control over workers. His project, a commercial success, had a strong sociopolitical dimension. It was designed to promote the democratic integration of the working classes, equality of opportunity, and antistatism.[9]

In the United States, a different sociopolitical project emerged, one of occupational mobility. Industrial engineers "were eager to assert their identity and extend their jurisdiction in management." Among other things, they were urged (in 1886) to involve themselves in work costing and accounting.[10] It was in this decade that Frederick Winslow Taylor began his reconceptualization of the engineering intervention, and his work would eventually lead to strengthened demand for engineering in production processes. He redesigned work methods, divided up tasks, and resorted to financial incentives or the employ of union-breaking

labor to ensure task performance. The bulk of Taylor's work can be viewed against a backdrop of a declining agricultural labor force, a doubling of exports in the 1890s, the beginning of the demise of the frontier mentality, and a 500 percent rise in union membership between 1897 and 1904.

First published in 1911, *The Principles of Scientific Management* expanded upon and applied to modern industry the central idea, inherited from the Enlightenment, that science could be a tool for human emancipation, a cure for a number of visible ills of industrial society. Taylorism involved two major elements:

> [F]irst, discovery by experiment of the best way of performing and the proper time for every operation and every component unit of an operation: in the light of the state of the art, the best material, tool, machine, manipulation of tool or machine, and the best flow of work and sequence of unit operations. These data were classified, indexed, and lodged in the data files for use as new orders came along. Second, a new division of labor as between management and workers: the assignment to management of the responsibility for discovering these best ways of performing units of operations, and the further responsibility of planning operations and actually making available at the proper time and place, and in the proper quantity, the materials, tools, instructions and other facilities required by workers.[11]

Demand for the system grew but slowly, owners and management opposed the usurpation of their prerogatives, and unions feared the loss of craft skills and overwork. Taylor preached the need for a "great mental revolution" that would unite labor and engineers in seeking to make the enterprise grow and, subsequently, a sharing of the fruits of this growth. Unionism also expanded rapidly, from 2 million members in 1904 to 5 million in 1920.[12] In the context of this rise and the production demands of World War I, an atmosphere sympathetic to collective bargaining developed, and after the recession of 1920–21 unions began promoting cooperation with management. Thus the political conditions for the acceptance of Taylorism were formed, and its expansion took place in a climate described by Nadworny as being one of "cooperation fever."[13]

The Birth of Institutionalized Safety Engineering

The demand for safety engineering predates its systematization as an intellectual subdiscipline. In the midst of the social conflicts of the 1900s, so-called "muck-raking" North American journalists were exposing the ills of the industrial system to the public. The climate spurred by revelations of frequently horrific deaths fueled public antibusiness sentiment.[14]

By 1906, U.S. Steel, a firm that remained one of the greatest accident producers, in spite of the use of safety inspectors since 1871, issued the following instructions: "The United States Steel Corporation expects its subsidiary companies to make every effort practicable to prevent injury to its employees. Expenditure necessary for such purposes will be authorized. Nothing which will add to the protection of the workman should be neglected."[15]

Other industries followed suit in what appeared to have been a set of ad hoc and spontaneous employer initiatives.[16] Demand appears to have had at least two faces: as a response to the economic costs of accidents and as a preemptive move to protect against the political pressure to introduce effective safety legislation.[17] Noble emphasized the second factor and perceived that it was in the area of safety that engineers probably made their most significant contribution to industrial relations.[18]

In 1912, safety engineering was subjected to an important attempt at institutionalization when the American Society of Mechanical Engineers sponsored the First National Safety Convention and, in 1914, formed the National Safety Council.[19] This would later become the largest safety organization in the world, grouping together individual and corporate members. Increasing its hegemony, it absorbed the American Society of Safety Engineers in 1924, an arrangement that lasted until the end of World War II.[20]

The early conceptual disarray of safety engineering as a discipline is clearly reflected in a sample article in a 1917 issue of the review *Industrial Management*. The article observes that slipping and tripping were the most common accident causes. In its discussion of prevention, however, the mechanisms suggested had little to do with the causes identified: oilers' platforms, a long-handled electric lamp remover, a cutout lamp hanger, sheet steel covers used to safeguard cranks, and devices permitting waste oil collection. In spite of such conceptual confusion over accidents, there was no disarray in the institution's purpose: it sought to stimulate employer demand for its services. "Safety pays big dividends" was the slogan-argument, and it was backed up by numbers designed to appeal to any investor: U.S. Steel was quoted as having made annual safety investments of around $700,000 over a three year period and having achieved an average annual return of $1,600,000.[21]

In 1931, the conceptual disarray that surrounded the area of safety engineering ended in the United States with the publication of *Industrial Accident Prevention: A Scientific Approach*. In it, Heinrich, an official of the Traveller's Insurance Company, assembled the diffused information available on engineering prevention, calculated accident costs, and de-

veloped a crude psychological approach to accident causes and a "state-of-the-art" engineering approach to prevention.

Like Taylor, Heinrich's method involved study of the workplace, the development of a theoretical notion that management interventions aided by engineering science would be capable of reducing difficulties (for Taylor low productivity, for Heinrich accidents) at work, and then, through a research process, the elaboration of specific methods for preventing accidents. The principles of a new subdiscipline—industrial safety engineering—became generalized as industry hired professional safety engineers and adopted standardized safety devices and procedures.

To ensure that the theory would have wide employer acceptance, Heinrich developed the notion that 88% of all accidents are primarily produced by the "human factor." By this logic, it is not employers who are responsible for accidents. Subsequent to this Heinrich developed a line of reasoning that produced an ingenious conceptual device, the "domino theory," which served to justify employer demand for safety engineering instead of behavior-modification programs. In this theory personal deficiencies, whether due to ancestry or social environment, are seen to be at the core of unsafe acts and/or mechanical failure. It is these factors that produce the accidents. By removing the human factor through engineering techniques, safety efforts will be most effective: "mechanical guarding and engineering revision are . . . important factors in preventing the most accidents."[22] It was proposed that accidents be studied, machines designed to eliminate the possible unplanned and unsafe act, "foolproof" devices conceived, and work processes and interrelations planned as prevention is integrated into employer routines. Accidents are seen to be produced by mechanisms similar to those which cause other production failures. Once these mechanisms are precisely understood, corrective action can be taken on the basis of firm engineering principles. The development of mechanisms to monitor safety practices, and the formal allocation of responsibility, ensure that scientific safety becomes a reality.

Through making favorable references to employee and union roles in safety, Heinrich tried both to remove barriers to the institution's development from the shop floor and to curry union demands for safety engineering principles.[23] By emphasizing that hidden accident costs are four times greater than measured costs, Heinrich sought to amplify employer demand by suggesting that the applications of safety engineering principles are handmaidens to increased profits. Through emphasizing that noninjury accidents are 300 times more frequent than major accidents, he was attempting to convince employers that by re-

ducing this source of waste increased efficiencies would be possible, and that safety engineers have skills appropriate to their realization. This process appears similar to that observed by Eliot Freidson in the medical profession, where "moral entrepreneurs" seek to increase demand for medical services by defining as illness and serious problems phenomena which lay people see as normal and minor.[24]

After initial acceptance in the United States, Heinrich's principles obtained wide acceptance in other industrial nations. They filtered into governmental institutions, the International Labour Organisation, and later the International Standards Association. Heinrich's book is less frequently referred to as "the safety man's bible" nowadays, but in retrospect, Heinrich was the revolutionary in the "great mental revolution" in industrial safety practices: his urgings brought engineering standards to the heart of private sector accident prevention efforts, similar to the way in which legal standards had earlier been placed at the heart of public sector accident prevention efforts.

Safety Engineering Revised: A Cost-Benefit Perception of Demand

In 1966, a third of a century after the systematization of the discipline came its first important conceptual revision. The simple link that Heinrich had postulated between safety and profit was, from an empirical viewpoint, a tenuous one.[25] It had a political function, however, in that it permitted the sometimes contradictory demands of employers and employees to be integrated by the same institution. In 1966, Bird and Germain's book, *Damage Control,* appeared. The authors sought expansion of the scope of safety engineering's intervention beyond the narrow focus on injury accidents. They emphasized that the institution's growth was dependent on its practices being closely allied to employer demands for profit, for whom it is necessary to estimate costs of all accidents, whether they result in injury or not, and to charge these against specific budgets. Bird and Germain observe that, in spite of the teachings of academic safety texts, most managers are not so charged and therefore have no incentive for dealing with accidents, and thus no responsibility for them. For this reason alone firms suffer unnecessary losses.

Using this simple principle, Bird and Germain discuss the example of the Lukens Steel Company, where property damage per million hours worked was reduced from $325,545 to $137,832 between 1959 and 1966.[26] The authors indicated that their method was, by 1966, in great demand, being applied in the United States, Canada, England, Holland, Australia, West Germany, Italy, and France.

Two sources of opposition can be expected to have played a role in reducing demand for damage control (or total loss control as it is sometimes called). Sectors of management that "resented the inference that they had tolerated gross waste of product and equipment through the years"[27] and unions. In their book, Bird and Germain portray workers as imbeciles[28] and ignore unions; the latter, however, do not ignore the authors! In Great Britain some unions opposed the introduction of damage control.[29]

"Safety equals profit" is, in spite of Bird and Germain's work, the slogan around which safety engineering balances the constant tension between external demands for profit and internal demands generated by the ethic of saving life and limb. Safety engineering's specialist journals reflect a yearning for more professional status, which they hope will better protect them from some of the conflicts between daily production demands and their own professional goals of workplace safety. Therefore, it is not surprising that a British survey depicted safety practitioners (as a group of safety engineers was called) as racked by self-doubt, placed in ambiguous roles, subject to changing demands, and suffering anxieties over identity and status.[30] Such tensions were also reported in a study of French mining engineers[31]; as we shall see these are common for members of other safety institutions. There is one category of engineers, however, those working with systemic safety, that has a utopian project for escaping such tensions.

Systemic Safety: Engineering Submitted to Safety

A new type of safety practice has emerged in recent times, in which safety is a precondition for production and sales. It goes under various names; for example, the United States Department of Defense calls it "system safety" and has defined it as "freedom from those conditions that can cause injury or death to personnel, or damage to or loss of equipment or property."[32] Its emergence is a product of certain intellectual advances made during World War II and further consolidated during the Korean War. Random failure, complex systems, operations research, and fault tree analysis were some of the notions and tools that propelled its intellectual development. The latter tool, created during the Minuteman project and later modified by the Boeing Corporation for computer analysis, cleared the way for systemic safety to become a saleable tool capable of being applied to meet industrial demands.[33]

Fault tree analysis operates in the following manner: one specific undesirable event, called the "top event," is identified and a logical diagram is then plotted in which, in its simplest form, events and condi-

tions are represented as being the logical outputs of other events and conditions. The probability of "primary events" that produce system breakdown are calculated under separately represented conditions; moving from the logical beginning to the top event, the probability of the latter can be calculated. This method was developed for multilinear systems with causal relationships that are sometimes simple and sometimes complex. The technical detail, the number of standardized measures of error that need to be used in any moderately complex system, and the number of permutations and combinations to be calculated had led to the use of sophisticated computer programs by the end of the 1960s and had built new demands for labor in aerospace, nuclear power, armaments, chemicals, and other industries. Reliability or system safety engineers, probabilistic risk analysts, and specialist consultants and programmers came forward to fill the demand.

Systemic safety differs from the safety engineering thus far examined on two counts. First, the principal economic markets in which units that employ systemic safety operate are noncompetitive, typically in state or monopoly sectors, such as the military and the aerospace and nuclear power industries. Second, whereas safety engineering sees investment in the material "forces of production" as the means for reducing accidents, systemic safety envisages investment in knowledge—in the production, storage, and control of information—as the means of building an accident-free production capability. In summary, then, systemic safety in its pure form appears to be a type of engineering submitted to the value of safety, which pursues its goals through investment in the production and transformation of knowledge.

Industrial Health and Medicine: Toward Scission

In Britain the government officially appointed its first medical inspector in 1898, the same year medical inspection was established in France. In these countries, and in the United States, however, individual companies had employed doctors and nurses well before these dates. By 1915 there was a sufficient number of occupational doctors in the United States to warrant their forming an association.

Health Care and Controversy

Rapid medical attention to the injured has been emphasized as reducing the consequences of injury accidents. This has served as one justification for the installation of (nonprofessional) first aid services and professional industrial medicine.[34] Another aspect of medical intervention has been observed, however, where injury victims are returned to

the job or to light work before they have completely recuperated, thus reducing the recorded severity of accidents as measured by lost working time. The former intervention is applauded by all, and the latter is applauded by those who benefit: insurance companies and employers. The latter types of efforts may be criticized by workers and unions and are often in conflict with the ethical ideal of the professionals defined, in the case of doctors, in the Hippocratic oath.

One study has provided a detailed examination of the manner in which company doctors, acting in a clinical role, "resolve" the conflicts of contradictory demands. Walters reports that these doctors work within a framework in which health, which always pertains to more than just accidents, is balanced against costs; a consequence of this is that the doctors are subject to management approval of their budgets plus pressures to minimize costs of lost work time. Interview data reveal that doctors acting within this framework are "often biased toward management priorities." To avoid losing credibility with workers, however, they frequently use scientific rationales to refrain from treating contentious cases and refer these to other doctors; in so doing, they are able to avoid any questioning that might reveal their "normal" (biased) role.[35]

A 1919 survey in the United States put the percentage of plants in which the doctor was ". . . a real medical director with freedom, responsibility, and authority to which he was entitled" at 4 percent and deduced that medicine had become a speciality "in the science of management."[36] However, submission to the demands of employers is not the only response available to doctors. The research by Walters indicates that some doctors "exit" from firms because of pressures and others try to exercise what Hirschman has called "voice" by building contacts with workers and unions.[37]

In the United States at the end of the 1930s, a body representing a part of the industrial health institution—industrial hygiene—broke into two rival associations: one had a membership base in the competitive sector and the other had its base in government. The split had an ostensibly ideological basis as can be seen from the criticisms made by W. G. Frederick, a prominent member of the American Conference of Governmental Hygienists, in his discussion of the American Industrial Hygiene Association: they "tend their primary loyalty to their employer and have rather consistently . . . and aggressively opposed steps forward to try and improve the health of the worker."[38]

We have learned how employers in France used various strategies to combat the development of an independent form of occupational medicine and how legal measures were taken to provide some guarantee of independence. We also have learned of independent doctors being offered positions within company career structures in an effort to submit

their practices to managerial direction.[39] The incompatibility of orientations between doctors who respond to different sets of demands can be seen in the debates in the review, *Médecine du Travail* and in the treatment of dissenters as "upstarts" by one of the British industrial medicine association's leaders.[40] During the early 1960s, medical personnel in Italy went further in their response to workers and took a vanguard role in helping workers articulate and formulate new health demands. In so doing they developed new roles as "servants of the workers," new methods of inquiry, and new conceptions of response to worker health problems.[41]

Industrial Health and Medicine—A Conclusion

Industrial medicine's initial narrow concerns have been characterized by Walsh as "medical Taylorism,"[42] in which medicine was involved in classifying and curing victims as well as selecting staff. The role of medical practitioners has since been enlarged, often in response to external demands, such as wartime needs and postwar rehabilitation, and to internal projects that sought to expand its role to include investment advice, research on working conditions, and liaison between shop floor and management. The growth of a medical profession whose practices were compatible with employer demands and interests was a feature of the advanced Western nations from the beginning of the century until the end of the 1960s. Accompanying this was a parallel growth of small but significant tensions within the institution as some practitioners responded to internal demands, interpreted through the affirmation of the Hippocratic oath and the autonomous identity defended therein, or to external demands that frequently reflected the interests of the workers' movement.

Industrial Psychology

Two further institutions that, like medicine, treat the worker as the key element in the accident picture are industrial psychology and ergonomics. The former seeks to understand and influence worker behavior and the latter to influence design. I shall treat psychology before turning to ergonomics.

Accident-Proneness Theory

In Hale and Hale's judgment, accident-proneness theory is "the most influential single theory in the history of accident research."[43] The key idea underlying this psychological theory—which is a central fea-

ture of safety posters and campaigns as well as one that has great influence on employers and engineers—appears to be drawn from common sense. We all know people who seem to be naturally clumsy and others who seem never to stumble, and rarely are we surprised when the former trip or hurt themselves. With this in mind, industry should avoid selecting personnel who are most likely to cause accidents, types of unsafe acts should be detected through accident report forms, and safety campaigns and training should seek to eliminate such acts.

The rise of psychological theories of industrial behavior, and especially the human relations school, is intimately linked to the limitations of engineering theories such as Taylorism and Fordism in accounting for human behavior.[44] From Farmer's conceptualization of accident proneness in 1926, built on earlier work by Greenwood stressing the importance of personal attributes in accident causation, Vernon argued in 1937 that prevention could be achieved if people were taught to be careful and thoughtful.[45] Soon after its formation, the concept gained currency in North America where, according to Berman, it was "picked up by a whole wave of industrial psychologists"[46] and elaborated upon by them.[47] A critique of the notion by Mintz and Blum in 1949 estimated that "60–80% [of accidents are] attributable to unpredictable factors."[48] This resulted in defensive articles and Ryan and Smith recommended job-transfer policies for certain individuals.[49] In following such a recommendation, the definitive experimental test of the theory's validity could be performed; however, tests have never shown significant results.[50] Faced with such a difficulty, the concept has become increasingly vague and subject to extensive remodeling. Hirschfeld and Behan, in an article deemed worthy of editorial acclaim in the *Journal of the American Medical Association,* saw accidents as being caused by "self-destructive ideas," and the 1966 *American Handbook of Psychiatry* referred to the implication of "impulsive character, anxiety reaction" in accidents.[51] Accident proneness has even been called a "failing to cope disease."[52] At the end of the 1960s the theory enjoyed great popularity, in spite of its lack of conceptual clarity and scientific validity.

How can the "marketing success" of a scientifically bankrupt theory be understood, especially against the background of what might be termed the contemporary "marketing failure" of fatigue theory, a theory also developed by industrial psychologists?

Fatigue Theory

Founded during World War I, the British Mental Health Board, later to become the Industrial Fatigue Research Board, produced a large number of research results that showed similar relationships between

fatigue and accidents. In 1918, Vernon published the most spectacular single result: an increase in work time from 60 to 72 hours was associated with two and a half times more accidents.[53] Research that advanced this and other notions about the ill effects of overwork made a strong impact at the International Labour Office: of the 30 conventions passed between 1919 and 1939, no less than eight referred to limitations of working hours or the work week.

Fatigue theory, however, was subjected to criticism based on various anomalous empirical results. The first was Vernon's discovery of lower accident rates on a theoretically more tiring night shift and the last was Ryan's demonstration in 1947 that the theory "covered a number of unstated assumptions connected with various subjective factors in the motivation to work that are unobservable and unmeasurable."[54] Rather than spurring new theorization, fatigue theory died. Subsequently, fatigue was treated as a type of neurosis in some writings,[55] and accident report forms, safety posters, teaching programs, and companies[56] ignored the theory's central idea—that tired workers have accidents.

Fatigue versus Accident-Proneness Theory

Demand for theories has various components, of which their capacity to reduce accidents is but one. The lack of demand for fatigue theory and the strong demand for accident-proneness theory may, in fact, be reverse sides of the same coin. It could be hypothesized that employer interests subvert demand for fatigue theory and add to the demand for accident-proneness theory. To be more specific, fatigue theory undermines the work ethic since it promotes the notion that too much work is not a good thing, and it also provides scientific legitimacy for one series of explanations of accidents that is rooted in worker notions of truth and justice. Embedded in this concept is an implicit threat to the existing order in the workplace. Is it for this reason that researchers are led to discard fatigue theory?

Further, it could be hypothesized that accident proneness is supported because it resurrects, in a secularized form, the idea that accidents are God's punishment for sin. The theory becomes attractive to employers because it provides a scientific notion that accidents are the workers' fault and, in so doing, legitimates their criticisms of those definitions that attribute responsibility to employers. Put simply, employers feel comfortable with a notion of accident proneness that is compatible with both their world views and interests. At the same time that it satisfies employers, it can be presented as "common sense" and used in training programs and poster campaigns to disarm politically charged

worker notions that accidents are produced by the way in which their relationships to work are managed.

This series of speculative hypotheses is indicative of the directions that could be pursued by researchers who seek a clearer understanding of demands for the services of different institutions and of the effects of such demand on the shape of final interventions.

Ergonomics

Chapanis has discussed ergonomics in the following terms:

> Although increased safety and, consequently reduction in the number of accidents are prime goals of human engineering [ergonomics], they are not the sole important objectives of this field. . . . major aims [include]: increasing the efficiency with which machines can be operated; increasing productivity in industrial and system operations; decreasing the amount of human effort required to operate machines; and increasing human comfort in man-machine systems.[57]

Through the application of methods, information, and laws drawn from engineering, anthropomorphy, medicine, physiology, psychology, and related disciplines, the ergonomist enters to serve demands.

Two Nations, Two Ergonomics: The United States and France

In the United States, human factors engineering emerged largely in response to the World War II needs of the armed forces. Social demands originated, not because of concerns related to justice, but rather because of concerns related to truth. The complexity of devices manufactured for the war effort, from radar to antiaircraft systems, meant that it became necessary to achieve a better understanding of the human factor since omission could lead to significant losses of personnel and equipment. It was in sectors where the problem was put most clearly in these terms that its application would grow the fastest.

The palpable origins of ergonomics in France span the immediate post-World War II period. However, Ribeill links its origins to the cumulative work of Marey, Chauveau, Amar, Fremont, Lahy, Imbert, and others in building a broadly conceived, experimentally based economy of human work prior to World War I.[58] Immediate post-World War II France had a government with a Communist ministerial presence that fostered the twin ideas that the ills of industrial capitalism could be combated through state action and that the promotion of science and technology could serve human emancipation. Research and teaching institutes of various types were created wherein ideas were developed

that would provide the basis for a specific form of ergonomics. Initial demand came from state-run industry in sectors where unionism was dominated by the Communist Confédération Générale du Travail (CGT): the coal industry and Renault.[59]

An important step toward the crystallization of ergonomics as a discipline occurred in 1959 with a conference sponsored by the European Productivity Agency. There, employer and worker representatives heard technicians and scientists define and treat problems that they saw as essential for work modification. Heavy physical work, factors in workplace layout, the presentation and use of information from the work process, the design of controls, lighting, noise, and climatic conditions, and biological factors in work were among the issues discussed.[60]

A diverse range of practical demands may be presented to the ergonomist: distribution of tasks between worker and machine, detailed job descriptions of complex work routines, design of monitoring or process control systems, or redesign of work stations and machines for given tasks. That different tasks have different demands is recognized, for example, the repair of an underwater oil platform requires that the professional draw on a different set of disciplines from those used in planning the repair of a nuclear power station.

By the end of the 1960s, the issues discussed at the 1959 conference were still being studied, and interventions were taking place in an ever-increasing variety of industries. Practices differed, however, on opposite sides of the Atlantic.

In France, according to an idealized portrait of ergonomics, workers would be studied closely, using interview techniques and field studies, and the knowledge gained would be fed back to workers. Ideally, the workers would be able to interpret the information in terms of their own understandings, and feedback channels would be available to permit questioning and dialogue. Trade union demands have reinforced the practice of these principles. Ergonomist Alain Wisner, sensitive to the questioning of the social structure that emerges when studies are performed using these methods, pragmatic in the need to maintain employer demand, and critical of leftists who would wish the discipline and profession to submit to demands that reflect their interests in undermining capitalism, delineates the professional's intervention thus: "The ergonomist's action must be placed on the threshold of technical economic and social structures which he will have identified and studied but upon which, in order to ensure the fullest efficiency of his own [limited] actions, he will not seek to act directly."[61]

Ergonomics as practiced in the United States and Britain do not

seem to pay attention to those structures that Wisner cites as being on the "threshold" of the ergonomist's "action." In the United States the focus is on segmented, technically narrowly defined, concrete aspects of productive activities,[62] with results being fed directly to employers, bypassing the workers altogether. The laboratory is preferred to field studies. The results produced, a direct consequence of the perspectives and methods used, are of such a nature as to respond to employer and not union interests and thereby to stimulate their demand.

Ergonomics: A Discipline in Scission?

Traditionally the two approaches have rarely engaged in debate or contact.[63] Their ideological scission is masked on a scientific front by a language barrier that is skillfully managed at international conferences and in the selection of papers in English language edited texts that seem to underplay differences. In the United States and France, both the initial development of the discipline and its present functioning through the interventions of professional ergonomists appear as responses to analytically different sets of external demands. In Brazil, the two approaches are integrated into the same association and a degree of tension exists between representatives of each, whereas in Japan, differences in approach have resulted in a dramatic scission that has led to the formation of two separate ergonomics associations.[64]

Interval: From the Private Sector to the State

The institutions thus far examined have been portrayed as dominated by the search to serve external markets. The growth of an institution appears to be intimately linked to the capacity of the market it serves to mobilize resources in its favor, to an institution's capacities to respond to the demands made, and to its capacities to widen markets for existing services and provide new ones. Institutional growth, however, does not imply submission to the demands of a single market; it can occur when demands from diverse sources are integrated. In the next section, state institutions will be examined. These appear to be dominated by a search for internal equilibria which would allow them to be perceived as negotiating a path between incompatible external demands—such is the essence of the external political legitimacy of state interventions.

Before examining state institutions, it is worthwhile recalling a lesson drawn from the previous chapter. The roles assumed by the state

are responses to political demands; there is nothing inherent in these roles to guarantee that social demands—such as the reduction of accidents or the provision of adequate compensation—will be met.

STATE-MANAGED COMPENSATION AND PREVENTION

Compensation

The modern model of compensation emerged in response to a number of different conflicts. One of these was the unpredictability of compensation payments made by firms and small-scale insurance schemes, which had consequences for their survival, and when they were unable to provide adequate payments, resulted in the economic ruin of victims and their families.

Justice and Adequacy of Compensation

At the heart of conflicts over compensation lie the twin issues of justice—the equal treatment of victims of similar accidents who have similar needs—and adequacy of compensation.

In Britain, the 1897 Workman's Compensation Act covered only a minority of workers and paid weekly compensation that was less than half of the average national wage. In 1906 nearly all forms of employment were covered, but this did not put an end to unequal treatment and inadequate compensation of victims.[65]

The United States was marked by grave inequalities in the payments of benefits. In Mississippi, the maximum payment for death to a widow and her children as published in 1976 was a lump sum of $15,000, whereas in New Hampshire dependents were entitled to $58,800. In Mississippi, the minimum payment for a widow was $10 a week. Beyond this, some sectors with particularly strong unions have been able to win demands for higher compensation: a longshoreman's widow may receive lifetime compensation worth more per annum than the Mississippi family's maximum one-time payment.[66] Ison coined the term "forensic lottery" to refer to the conception of social justice underlying inequalities in entitlement.[67]

In France, equity has been sought through a system of standardizing payments for injuries of varying severities and to various parts of the body. For temporary incapacity to work, 50 percent of the victim's salary is paid for the first month and in subsequent months, 67 percent. The

loss of a thumb and index finger are worth 48 percent of the standard payment, that of an ordinary finger 10 percent, and so forth.[68]

The French system avoids the jarring inequalities in compensation payments found in the nonstandardized system in the United States. This does not mean to say, however, that all is a bed of roses, since diverse mechanisms exist by which payouts can be lowered and this affects certain categories unequally: immigrants, for example, are alleged to suffer discrimination.[69]

France–United States Differences

United States. The differences between the two countries need to be examined in slightly more depth. In the United States, compensation is regulated by state, not federal, laws. Its early institutionalization produced two models: insurance-company and state-controlled compensation. By 1915, state-owned schemes were introduced in 13 states.[70] In subsequent years, insurance companies were to guarantee their control of schemes in all but a handful of the remaining states. For Berman, state-controlled schemes often emerged in contexts of strong political demands by unions and socialists. They are more efficient because they pay a higher proportion of premiums in benefits than do private schemes. State-run schemes had an average benefit/premium ratio of 0.72 whereas for private schemes this was 0.53 in 1974.[71]

Insurance administration is not the only cause of variations in payout; another is the strength of unions in certain key areas, which through collective bargaining may guarantee rates above the legal minimum. In addition, unions employ lawyers, and where employers' liability is in question victim benefits may be further raised through legal action.

The observed inequality in compensation payouts translates into unequal costs for employers in different regions and sectors of the economy. The effects of such differences on the structuring of the competitive sector were but one of the concerns of the American Association for Labor Legislation. Organized in 1906, it had among its aims the standardization of compensation and safety legislation.[72]

Private insurance interests are seen by Berman as having sufficient political strength to avoid state government control, which, even maintaining the same insurance payments by employers, would lower administration costs thereby resulting in considerable improvements in payouts to victims. Insurance interests are seen to have entered into alliance with employers to restrict benefit payments.[73] In some sectors,

however, such restrictions were not accepted: the 1946 coal miners' strike, for example, resulted in additional medical benefits. For Lubove, "Workmen's compensation never overcame its original structural deficiencies, rooted in benefit schedules adapted more to business imperatives than to the objective needs of injured workers."[74] The monetary consequences to workers of this system were estimated in 1972 at $18.2 billion in wages lost as a result of recognized work injuries and disease, yet compensation payments were a mere $4 billion.[75]

France. The fragmented French system of compensation was replaced in 1946 by a unified state-managed national system and benefits henceforth paid on an egalitarian basis. An association of accident victims, organized since 1920 has, in addition, been judged to have successfully pressured for increases in payment levels.

The passage of Martin Nadaud's compensation bill in France in 1898 received little attention from the union movement. It made accidents the legal responsibility of the employer and only in special cases of serious misconduct could the courts award damages above legally set levels. Compensation had become a right, yet the law permitted some opting out of the state-sponsored scheme. For those employed by firms that opted out, compensation, especially if the firm were to declare insolvency, was an uncertain affair. In reaction to this, and as protection from other forms of uncertainty, some workers formed cooperatives, called "mutuelles"; descendents of the guilds, they would have nearly 5 million members in 1910 and nearly double this number on the eve of World War II.

Political challenge to employers and state over compensation levels, however, would come from quarters other than the mutuelles. The increasing misery of victims compensated by the state system which was run by private insurers, a system that did not readjust payments in line with inflation, became transformed into a political problem. Under banners that included demands for higher payments and coverage of all workers, the Association of the Working Wounded won, in 1922, the first readjustment since compensation was introduced, and further readjustments followed in 1929 and 1946.

The postwar coalition government moved to resolve some of the prewar critiques of the institution. Internal reorganization occurred in response to external, largely worker and union, demands. A National Fund for Health Insurance (CNAM), operating at a regional level (CRAM), was formed to replace private sector accident insurance. After this reform only a few traditional "private" schemes continued to operate, and these were located in public sectors such as electricity and

railways. A corps of inspectors with the twin missions of education and enforcement was founded. This corps, which the union movement initially participated in running, was the compensation institution's response to accidents. Working independently of Labor Ministry inspectors, but like the Ministry, it seeks to ensure equal investments in standard safety measures by employers; if persuasion does not work it can threaten to raise levies in those workplaces that do not meet the norms. Reflecting the previous performance of large companies and the average sectorial performance of small companies, general levies are structured with the rationale of providing economic incentives for employers to invest in effective action to prevent accidents and illness.

The French system can thus be seen to have been shaped through the pressures of a social movement engaged in an economic struggle and a period of postwar political alliances. It guarantees both predictable and equitable levy costs to all employers in a given sector. Benefits are conceived of as being at a level that permits victims and their dependents to retain a considerable part of their former purchasing power.[76]

The contrast with the United States system, built up in an unintegrated and inequitable form, which treats industrialists and victims unequally, is marked. In comparative terms, the United States system appears pregnant with a potential source of moral outrage and political conflict. Any transformation of disfavored industrialists or victims into political actors could be expected to play a role in reshaping the institution.

Prevention

In most countries systematic state intervention in the arena of prevention seems to have emerged before compensation. Great Britain provides a clearer example of this than France, for in the latter the fundamental accident prevention law was passed only five years before the 1898 compensation law. In the United States prevention legislation generally emerged in a decentralized and disarticulated fashion, but most of the heavily industrialized states had forms of safety laws before the arrival of compensation laws.[77]

Industrial conflict around accidents in Great Britain became a political problem and, in order to neutralize it, safety laws seen as beneficial by workers were passed. They were to be administered and offenders judged in a manner seen as impartial. In different nations and sectors this same basic model is followed. Legal standards may be narrow and extremely rigid in some places, all-encompassing and open to interpretation in others; platoons of full-time inspectors in one nation may

contrast with the armies of part-timers in another; inspectors may double as judges imposing instant penalties in one area yet appear as mere educators in another; and required standards of proof and the rigor of sentences may vary widely.

Early industrial safety legislation—and British coal mining is a case that illustrates the general rule—grew up in an ad hoc manner. Specialized laws and inspectorates frequently developed in response to the differing functional demands of a variety of activities—shipping, boiler making, workshops—and such functional scission frequently led to jurisdictional conflicts between inspectorates. So general was such scission, yet so widespread the troika system of laws, inspectors, and courts, that in the 1920s the International Labour Office analyzed the role of the factory inspectorate in 25 countries (but not the United States) and judged: "Despite national peculiarities, however, factory inspection appears to have grown up in response to certain governing needs. Its historical development in all its diversity seems to have taken the same paths, or at any rate tended in the same general direction, in spite of some divergences."[78]

Observers of the legal prevention institution, such as Carson in Great Britain, Juffe in France, and Page and O'Brien in the United States,[79] taking the early 1970s as their reference point, have noted little significant change since the beginning of the century in the administration of laws. During this period, however, a great enlargement in their activities, beyond their original narrow foci, had taken place.

Three discrete areas of activity shall be treated: legislation, inspection, and the judiciary.

Legislation

The structural similarities between legal prevention apparatuses permit their examination within the same analytical framework. The pattern set in early British coal mining of laws determining, through standardized measures, what is legally safe came to be universally adopted by legislatures. In the United States coal-mining sector over 60,000 lives were claimed and over 250 disasters occurred between 1910 and 1940; however, during this period no new federal laws were passed. Curran explains this as due to a weakening of the union movement linked to the dropping demand for coal. The onset of World War II saw a rise in demand, a number of disasters, a strengthening of unions, and, in 1941, new mine safety laws.[80] In Britain, the 1901 Factories and Workshops Act, although amended in response to ad hoc demands, was revised, consolidated, and built new standards in 1937, in the post-

Depression climate when shop floor demands played a prime role. The next reform occurred in 1961 and aimed to strengthen laws weakened by a series of judicial interpretations. The 1950s and early 1960s saw Labour and Conservative governments increase protection in several sectors: agriculture (in 1952 and 1956), shops (in 1963), and nuclear installations (in 1959, 1965, and 1969).[81]

Legislative changes occur in response to new demands and these may vary in nature: responding to social movements, satisfying political compromises, consolidating administratively disintegrated structures, suppressing technical accident causes, or simply providing a market for new prevention techniques. Within the same sector in different countries technically focused regulations may differ widely. The 1906 Courrières explosion claimed over 1,000 French miners. In 1937, Major H. Hudspeth compared British and French mines and concluded that the deaths caused by explosions occurred in the former nation at three times the rate of the latter especially because of the latter's stricter ventilation regulations.[82] The rigor of the French law (and this cannot be dissociated from the effects of the disaster and the extreme violence of the protests it provoked) is seen as a key determinant of the fact that France, with a quarter of the labor force of Britain, lost 58 miners in explosions between 1925 and 1934, whereas Britain lost 753 during the same period. Different external demands produce different institutional interventions and, in this case, are associated with variations in rates of accidents from a given technically defined cause.

A key idea underlying this book is that the use of standards is itself a social act; a further social act is the production of the exact standards developed, whether or not they are submitted for legislative approval.[83] Demands for standards, I would hypothesize, must have a political base to find their way into safety legislation. The absence of strict antiexplosion regulations in Britain, when compared with France, would appear to confirm such a notion.

Inspection

Inspectorates were set up everywhere to administer the laws. Differing in numbers, roles, composition, orientation, and autonomy, their histories appear closely linked to those of political demands for safety and of reactions to them.

Readers may recall Ashford's earlier observation on differences in ratios of working population to inspectors (see p. 46 and note 5). The crucial question is, however, whether the fact that Finland has close to five times as many inspectors per worker as the United States means

that its safety performance will be better? The answer depends on a precise constellation of factors with complex interactions.

Different Roles for Inspectors. Inspectors may be accorded a punitive role with the capacity to shut down machinery or to hand out instant fines. Inspectors of the French CRAMs can theoretically raise levies by up to 200 percent in case of offenses. Other inspectorates may have a primarily educational role by showing employers how to comply with regulations. The educational role appears common to a variety of countries, including Great Britain and Sweden. Few inspectorates play a single role. Public outcries or disastrous accidents may be followed by punitive blitzes, and a series of successful prosecutions may result in employer demands for educational programs. The way in which both unions and employers treat inspectors will be, at least in part, a reaction to the role taken and the power of sanction inherent in it. A unique insider's view into the operation of a United States inspectorate in the 1980s is provided by Lofgren, who reported employers, frequently echoing sentiments found in nineteenth-century Britain, saying, "Why do I have to buy all this safety stuff when my competitor down the street doesn't have to?" The inequity is revealed in the reason "because only a token number of companies in an industry are inspected and forced to comply."[84]

Recruitment of Inspectors. The composition of inspectorates is another part of the constellation that historically influenced the efficiency of the legal intervention. Through demands for workmen's inspectors, entrance qualifications that would permit worker entry to safety inspectorates, or that recruitment be by public examination, unions have sought to ensure that inspectors, if not recruited to be frankly favorable to workers, at least would be recruited in a neutral fashion. In the early years of the British factories inspectorate, employers insisted that recruitment be carried out within the ranks of the upper classes, since, being "men of honor," such recruits would not reveal trade secrets.

The initial formal prerequisite for British selection of factory inspectors was a bureaucratic response to the employers' demand: a requirement was a high educational level, thus effectively shutting out working-class recruitment; this prerequisite was justified by referring to the complexities of administering technical standards. By 1893, the political climate had changed and a category of inspector that did not require higher education was formed.

Recruitment was thoroughly debated in 1909 within the French section of the International Association for Labor Legislation. The associa-

tion's members unanimously agreed that workers should be admitted as inspectors. Subsequently, medical and engineering graduates lost their easy access to appointments and the selection process was restructured to favor the recruitment of workers. By 1923, the dual British system was phased out in accordance with the argument that working-class educational levels had risen sufficiently to permit workers to compete on an equal footing with candidates from other social classes.[85]

The direct nomination of workers as inspectors, and their protection under law, would ensure that safety legislation be administered independently of employer demands. Such was the argument behind the worker campaign to bypass the state bureaucracy and install their own inspectors. This argument was so successfully resisted by employers that workmen's inspectors would achieve legal recognition and protection only in the coal-mining sector in some European nations and British colonies.

External demands of conflicting actors were brought to bear in shaping the modern labor inspectorates. They did not clearly determine the advantage of one demander over another. Selection criteria sought to guarantee that the inspectorate would not be staffed by individuals or groups predisposed to act unfavorably toward either employers or workers.

Administrative Controls on Activities. Demands form internally to ensure that the inspectors act in a manner that is seen to be neutral. Training programs exist to transform the recruit into a neutral servant of the inspectorate's machinery, and later to keep up to date with changing technologies or legal requirements. The autonomy of inspectors is frequently limited. The French Labor Ministry maintains a centralized control structure that evaluates all registered infractions to ensure that only winnable cases are brought to court against employers.[86] In Britain, a centralized administrative control structure has traditionally operated to achieve uniformity in the interpretation and application of factory laws.

It must be asked whether the inspectorate's administration satisfies internal demands for neutrality? We observe, by way of example, that French work inspectors registered 22,841 offenses in 1967 and only 6,828 were subjected to legal sanction.[87] In Britain the Chief Inspector of Factories did not report the number of offenses registered in 1970. However, 556 fatalities and over 300,000 injury accidents were registered, but only 2,940 prosecutions made.[88] Such figures reproduce themselves in other countries and lead various authors to deduce that the safety inspectorate's claims to neutrality are a sham.[89]

Considerable evidence can be mustered to support such a view. In a

series of French construction site studies, I found executive managers referring to their use of "political relations" to deliver themselves from threatened prosecutions. In New Zealand a site manager told me, "I'm not afraid of them, they've got no teeth." Commissions of Inquiry frequently scold individual inspectors for "lapses" that lead to disaster accidents, but they do not see these as representative of more general practices.[90] But such observations are not in any way to be taken as suggestions that employers view inspectorates as having no coercive potential; such potential is recognized and laws and inspections do have effects on safety practices. What exactly these effects are, how they articulate into successful accident prevention, and how they are produced are matters for further investigation.

Inspectorates under Strain. Such observations have a political content, and inspectors can be seen as the meat in an apparently administrative, or otherwise defined, political sandwich. Up until the end of the 1960s, they prosecuted rarely in the countries examined. When inspectors adopt an educational or persuasive orientation, they may see themselves as independent agents who, by avoiding confrontations with employers, can do more for safety than would be possible through alternative actions based on prosecutions. Such a viewpoint permits employer demands for impunity and institutional demands for law enforcement to be integrated. However, inspectors do reject employer demands for impunity, either by reference to their institutional role or by reference to external demands from other actors. When such rejection occurs, if their own superiors systematically veto punitive action, the conditions are built for scission within the inspectorate or, where the inspectorate is united, an institutional crisis.

The Judiciary

The final aspect of state prevention efforts to be examined is the justice system. Prosecuted offenses are heard by a judge who weighs the evidence and delivers decisions. In the more advanced democratic societies, the judiciary normally acts with a great deal of autonomy from direct political demands. How do we explain that sentences appear to be light even in the most extreme cases in which industrial lawbreaking causes death? In France, in 1972, only 75 of the 7,500 illegal acts sanctioned resulted in fines above the legal minimum.[91] In Great Britain, the average fine imposed in 1970 was less than 40 pounds.[92]

Supporters of the judiciary can produce a large number of argu-

ments to defend its claims to neutrality. The technical nature of safety legislation is alleged to make the law difficult to administer. Defendants, when they are employers, invest large sums in expert witnesses and lawyers in comparison with the prosecuting inspectorates. In the majority of cases first offenders are dealt with. Attenuating circumstances are frequently to be found because workers are blamed for the illegal acts or because civil responsibilities with respect to the compensation of victims have been carried out.

Critics argue that low fines are a powerful indicator that the judiciary submits to the demands of employers. As early as 1920, Lord Justice Scrutton referred to the British judiciary thus: "How can a labour man or a trade unionist get impartial justice? ... [judges] all move in the same circles as the employers and they are all educated and nursed on the same ideas as employers."[93]

From Submission or Integration to Scission. The merits of each position need to be examined empirically. Independent of such research, both defenders and critics seem to agree on one general point: that the judiciary has a legitimate role in the area of industrial safety. However, for one group the law and mechanisms for its administration should be revised, for the other the judiciary should cease to serve employer interests and assume its legitimate role at the service of justice or, for some, as a servant of the oppressed. From the late 1950s, a scission slowly emerged within the French judiciary that was based on the development of an alternative conception of the judiciary's role. The scission eventually became public in a case relating to industrial accidents.

Pierre Cam has described the emergence of this scission. In the post-World War II period, judges were increasingly recruited from outside the ranks of the upper classes. Influenced by progressive Roman Catholic ideologies of justice and by trade union demands, some of these recruits slowly started to produce new interpretations of work legislation. These modifications did not pass without contest from employers and even unions.[94]

State Prevention: Conclusion

Criticisms are directed toward all aspects of state preventive action. Some point to the difficulties with the standards approach adopted, and in so doing, the perverse effects identified in Chapter 1 may be subject to discussion. These problems add to the gaps produced by legislation that is essentially ad hoc, frequently lags behind technological develop-

ment, and is overseen by functionally distinct administrations. Administrations are rarely seen as having adequate staff to supervise the law. Even if staffing were adequate, for example, the Wisconsin Department of Industry, Labor and Human Relations has estimated that their action would only be able to prevent 25 percent of accidents.[95] Criticized because they prefer education to punishment, when inspectorates do take cases to court, these cases receive low fines on conviction. In this context an objective basis is provided upon which criticisms from external sources can be developed: instead of being concerned with worker well-being, the institution may be perceived of as serving employer demands. Faced with such an unfavorable judgment, it is interesting to note, at end of the 1960s, both the absence of important internal scissions within the institution and of strong union demands for structural reforms.

UNIONS AND WORKERS

Throughout much of this discussion, unions and workers have been portrayed as a minor force. Given that workers are the victims of accidents, how can this be understood?

In spite of different national histories, some remarkable parallels can be found in the manner in which workers and unions in advanced democratic nations treat industrial safety and related issues. From the end of the 1910s, a period of social peace and limited union demands existed with regard to questions of safety and compensation. From the end of the 1960s a series of movements erupted that, allied with elements within safety institutions subject to scission, produced the climate for the reforms that would change safety and compensation institutions in the 1970s and the 1980s.

In research on coal mine safety in the United States, Graebner notes that union national conferences ceased to debate accidents from 1912 onward.[96] This date is seen as marking the beginning of a period of institutionalization of both safety and compensation. Page and O'Brien report that a similar phenomenon occured at a general level in the United States, and in Britain, Eva and Oswald observe that unions adopted a passive orientation expecting that health and safety could be trusted to government for action.[97] The attention given the question of safety in the writings on this period leads one to infer a generalized union silence in countries as different as Japan and Brazil as well as in the more standard references of developed European countries and out-

posts, Australia, Sweden, Italy, and New Zealand. Exceptions to the rule do, of course, exist. Disaster accidents provoked sporadic revolts. In France the Communist union CGT occasionally included accidents as a focus in its campaigns. That country's union movement has already been portrayed as having a role in formulating demand for and in shaping ergonomics. In the United States miners fought the company doctor system from the mid-1930s, a struggle that would eventually lead to the setting up of a welfare and retirement fund.[98] Also, during the 1920s the Workers' Health Bureau organized and campaigned. Its goal was to make health and safety class issues and, at a practical level, to have federal laws passed. The bureau's dismantling came in 1924, and for a telling reason—mainly because of a union movement decision to withdraw its limited, but important, support.[99]

One important factor in producing union silence was the institutionalization of safety and compensation demands in an arena of "neutral," generally state, action. Up until the Great Depression, British unionists saw safety as achievable through better legislation. They abandoned this position only to return to it in the 1950s, requesting more of the same old pattern of state action: inspectors, powers for inspectors, and improved standards.[100] However, some unions played an active role in safety by adopting the perspectives of employers. Unions showed a limited acceptance of the notion of "worker carelessness" in United States mines and in British mines in 1923 where a "safety first" campaign was endorsed.[101] Heinrich referred to the importance of union assistance in the creation of a successful safety program and endorsed the general principle of union cooperation—"directed properly"—with management.[102]

Workers' demands for safety may be ignored by "scab unions," by unions that feel the pressure of unemployment, and by those with an economistic perspective. In the French construction industry, I observed "bosses unions" acting in favor of employers and against workers on questions related to danger. During the 1930s, a company-backed South Wales Miners' Industrial Union accepted poor adherence to safety regulations and was seen as insufficiently concerned about compensation, with such actions fought by a breakaway union.[103]

Unions may passively cooperate with management approaches to safety; a fear of unemployment is seen to have led British union bureaucrats to shelve safety demands during the Great Depression. In postdepression years, economic issues took center stage: unions emphasized compensation payments and, by placing emphasis on hazard pay, came to actively endorse the performance of dangerous work.[104] In a

similar manner in the 1950s, the Italian union Confederazione Italiana Sindacati Liberi (CISL) demanded that job dangers be compensated for by extra payments to exposed workers.[105]

Why Do Unions Give Low Priority to Safety?

There are two approaches to understanding why unions give low priority to worker demands for industrial safety and appear to be integrated with or subordinated to employer or state models of safety. One approach emphasizes workplace dynamics, the other considers the effects of a number of macrosocial processes. I will turn to an examination of each.

Workplace Dynamics

New workplace dynamics have been produced as a result of the formation of new intermediary institutions in the workplace that link worker and employer in the site, factory, or office. Working cooperatively, employers hope to manage those aspects of the workplace functioning that they see as problematic: quality, productivity, waste, safety, and the like. Safety committees, representatives, workforce participation, delegates, and the like are introduced at the demand of insurance companies, legislation, employers, or unions. The International Labour Organisation has proposed safety committees since 1928.[106] Different sponsors may have different motives. The Italian Fascist government endorsed union participation in efforts to convince workers of the importance of safety.[107] The French Pétain government sponsored safety committees in 1941–1942 to weaken union power and increase state power over workers. After liberation the government legislated to retain committees, seeing them as a means for protecting workers.[108]

The intermediary workplace institutions built may take on a wide variety of forms: an employer may appoint one member of the workforce as a safety representative, all workers may elect their safety committee, these combinations may be reversed, or an intermediate form devised. Selection methods may be determined by powerful actors with the aim of producing an intermediary who will represent defined interests. Membership may be designed so as to submit activities to the demands of powerful actors. The area of legitimate action may range from being highly restricted to wide open. As a function of the play between unions, employers, and the state, the institution may end up with little real power or, on the contrary, it may be endowed with the capacity to make sovereign investment decisions. Faced with such a

variety of possible forms it is impossible to make general a priori statements about the effects of such interventions.

This general type of institutional innovation in the workplace finds wide support, yet, strangely, research carried out during the prerupture years does not show it as achieving its stated goal.[109] Its "success" can probably best be understood by reference to its political functions: it permits workplace conflict to be appeased by a go-between that is recognized as legitimate by both worker and employer. In so doing it may contribute to the reduction of accidents, for example, by operating as a mechanism for calling attention to sources of danger. However, the institution may induce a general perception, by causing more smoke than fire, that all relevant dangers are being taken care of. In so doing it may placate complaints that would normally be aired in the form of what Hirschman has called "voice" (see note 37).

The political role of the intermediary workplace institutions can be interpreted as dispelling workplace conflicts. This is done when unions and worker representatives are integrated into the management of safety in such a way that agendas are fixed in function of employer models. However, for the intermediary institution to retain this role, the part played by worker participants must maintain a semblance of legitimacy among nonparticipant workers.

Macrolevel Dynamics

At the macrolevel a series of links between widely observed phenomena such as the bureaucratization of trade unions, the embourgeoisement of workers, and the effectiveness of compensation and prevention can be woven into another explanation for union inaction regarding safety.

With the rise of mechanized productive systems and the concomitant decline of craft production, important foundations of which are discussed by Taylor and Ford, manual work was emptied of its intellectual content, became degraded, and workers viewed it negatively. In a parallel transformation, production activity was becoming less central to life as working hours declined and changes in consumption occurred. One example of the latter is that improved transportation enabled urban laborers to live at a greater distance from their work and to cultivate new lifestyles as a result. Consumption began to displace production as a central part of workers' lives, and work was seen by these newly "embourgeoisified" workers in increasingly instrumental terms.[110]

The bureaucratization of the trade union movement can be seen as one manifestation of a general movement in a rationalizing society that

separates mental and manual labor. Union activity in general, and the increasing role of negotiations with employers and state in particular, demand that officials be equipped with skills appropriate to treat complex legal, technical, and even economic issues. The time available to professional unionists becomes increasingly taken up with political and administrative matters, and consequently less time is available for the in-depth treatment of workplace realities.

Unions are, in general, democratic organizations. Like any other democratic leader, union leaders seek visible signs of success in order to attract future electoral support. Referring to this principle, British unionists were seen to have dedicated their efforts to obtaining national reforms in such visible areas as compensation payments and safety legislation, rather than seeking changes in working conditions that would reduce accidents in individual workplaces.[111] Bacow, discussing the United States, explains union inaction by reference to this same idea: "Unlike wage gains the benefits from improved health and safety conditions are not always immediately apparent to the rank and file."[112]

Safety is negotiated and one of the many possible benefits of such negotiation is that it helps union leaders to win elections. At whatever level it occurs, from the humble site safety committee to the tripartite national conference, negotiation presupposes a common agreement on the grounds for discussion. In examining the early history of prevention, we saw that an approach to safety which emphasized the positive role of worker autonomy was rejected. For employers their right to control this factor was a nonnegotiable one.[113] Safety became a negotiable issue with the discovery of an administrative solution: the emergence of engineering-based standards left a space for employer and union disagreement over details, yet allowed the details to be discussed on a common ground, before reaching a final compromise. With state-administered compensation, the mechanism is similar. Put another way, safety was treated by mechanisms comparable to those that, in more recent times, are common in large and progressive industrial organizations for resolving conflicts of interest over issues such as wages, dismissals, and seniority. Snapped out of the realm of industrial conflict, these are treated by recourse to the administration of rules which have been established by prior negotiation and agreement by union (or designated worker representation) and employer.[114]

Evaluating Union Efforts: Positive Evaluation

The institutionalization of safety and the bureaucratization of unions can be interpreted both positively and negatively. A positive

interpretation can be constructed as follows: through their lobbying for better laws and safety administration and through constant recourse to negotiation at all levels, unions are contributing to the reduction of accident rates. Where such rates are difficult to lower, the negotiation strategy leads to wage increases in recognition of the hazards and, should the worst happen, to relative increases in compensation payments and rehabilitation services. Better results are obtained by unions through this process than workers would be capable of achieving by their own efforts.

In the evidence published in 1842 by the Children's Employment Commission, we saw some British miners fatalistically accepted accidents; 117 years later a Turin survey showed that 65 percent of workers still believed that damage in the workplace (including accidents) was, for practical purposes, inevitable.[115] Numerous workers, in initial stages of interviewing during the field studies I have conducted, attributed accidents to human carelessness. Significantly, sections of management decry such attitudes and seek to instill "safety consciousness" in workers as a means of prevention.[116] The juxtaposition of fatalistic workers with institutionally active unions[117] would provide a strong case for the positive evaluation of the latter's action.

Evaluating Union Efforts: Negative Evaluation and Scission

The organization of a different constellation of factors leads to a negative evaluation. It may be arrived at through an argument traced along the following lines: the institutionalization of safety conflicts, in a process of negotiation that limits their content, has removed the only organized vehicle through which those worker safety demands that have a social content can be expressed. The organized vehicle for workers is the union movement. When it becomes a political force, it separates from the workers' movement because of the imperatives of the negotiation process, and as a result either ignores or becomes unconscious of socially expressed demands. The workers' movement is left without access to institutional channels for the articulation of its social demands.

This negative evaluation finds support in both historical and contemporary research: workers are concerned about accidents and express views on cause and prevention that differ from the dominant ones. In France, psychopathologist Christophe Dejours has demonstrated, with extraordinary force, the anguish and fear hidden behind the defense mechanisms and supposed apathy of many who labor in dangerous industries.[118] The Children's Employment Commission hearings de-

picted workers expressing their concerns through which certain views on accidents emerged, each implying a different approach toward industrial safety. One view was that accidents were a product of what contemporary sociology might call the social relations of work. The 1907 Building Accidents Committee in Britain saw witnesses explaining accidents as products of piecework, excessive hours, inadequate training, and site disorganization.[119] Such analyses implied, in a manner closely paralleling that found among workers studied some 68 years later in a New Zealand construction site,[120] that changed social relations would lower accident rates. Such a phenomenon was repeated in further studies, some of which will be analyzed in Chapters 3 and 5, and has been reported in the literature that lends itself to sociological interpretation.

A cultural tradition in which ideas of truth and justice were expressed emerges as a constant reference. This occurs in spite of the bureaucratization of job procedures, the existence of some safety committees that to varying degrees take account of worker complaints, the roles played by engineers in planning and controlling work, strong instrumental orientations among many workers, and other factors prime among which is the propagation of accident-proneness ideology. Social explanations of the production of accidents, combined with a contained moral outrage at their perceived causes, would be found to be commonplace.

Such visions are a long way from the political visions held by the trade union movement. The contrast between the workers' socially based perceptions and the unionists' rationalized and politically located perceptions is a clear indication of the existence of a scission between the workers and the union movement with respect to accidents.

THE RUPTURE

Studies from the United States illustrate this last point: the union movement perceives safety in a manner different to workers. A survey by the Upjohn Institute found that unionized automobile and steel workers placed job health and safety issues at the top of their priorities. This was corroborated by a national survey which found that in "the labor standards areas . . . most important to workers were those relating principally to the general area of health and safety."[121] In the Upjohn study, union leaders and top management "both thought money rather than working conditions deserved the most attention, an almost exact reversal of the blue collar attitudes."[122] In other words, these are clear signs that the union movement integrates an uneasy tension between

political demands, which are perceived, built, and responded to by its leadership, and social demands from its base.

This uneasy integration periodically came to the surface as scission during the years of social peace, especially in the form of wildcat strikes on safety issues. Wildcat strikes in unionized sectors of the economy occur when workers move against both union and employer.

By the end of the 1960s, the scission in the union movement was increasingly coming to the surface in the United States. In Donnelly's analysis,

> beginning in the mid-1960s, wage issues became less important as a source of worker unrest. Grievance procedure, union local autonomy, working conditions, speed-ups and safety and health conditions were cited with increasing regularity as sources of conflict between the rank and file and their union officials and management.[123]

In Britain the shop steward movement which had grown up in opposition to institutionalized union bureaucracies was associated in the early 1960s with increased wildcat strikes, and it has been suggested that this helped provoke subsequent changes in state prevention efforts.[124]

Such developments taking place below the surface were building the political power of the workers' movement in opposition to the union movement, and they eventually broke through in wildcat strikes in many advanced industrial countries. The workers' movement has been discussed in industries as diverse as the United States coal mines[125] and French shipbuilding.[126] In Italy,[127] Canada,[128] Sweden,[129] and Australia,[130] worker movements in favor of safety, erupting from the shop floor, broke with traditional union positions and with the social peace that had for so long surrounded the problem of accidents.

Crossing the Rubicon

The social movements that began in the late 1960s and resonated through to the late 1970s challenged nearly all important domains of life in the advanced capitalist nations and, in limited cases such as Rio de Janeiro and Prague, beyond. In the field of industrial safety, wildcat strikes and worker demands for safety were but a visible sign of far deeper movements. Some institutions that appeared to be submitted to a set of external demands developed contradictory internal demands that were difficult to integrate. Some institutions that had integrated contradictory external demands split. Industrial safety moved from being a private and invisible issue to a publicly visible one.

Professionals and bureaucrats, in both the government and private sectors, felt the rupture. In France, factory inspectors ended a period of

quiet integration when some adherents to Socialist and Communist-affiliated unions publicly demanded new safety practices. In a clear break with what was interpreted to be the judiciary's submission to employer demands, a judge, linked to France's emerging Syndicat de la Magistrature, imprisoned an employer for endangering his staff. In the United States, some doctors raised their heads and denounced, on ethical grounds, the "company doctor" system. Lawyers, doctors, factory inspectors, academics, and workers combined with groups of political and ecological militants in the United States to form Committees for Occupational Safety and Health (COSH) and thereby became foci of potential scission in their institutions. The pattern was copied in Canada and in Britain. In Italy, medical professionals were a key influence as they attacked those barriers to worker knowledge that resulted in worker death and ill health. In Britain, scientists vocally opposed the use of poisonous chemicals in the belief, inherited from the Enlightenment, that the enhancement of human well-being is a key component of science; in the United States their peers followed suit. In return, trade unions everywhere reevaluated not only their links with their bases but also their demands on the state and their relationship with certain groups among safety professionals.

The safety and compensation practices that had dominated the twentieth century were questioned during the rupture. Such questioning would reveal a system which, in terms of its publicly professed social goal, had become a failure. It was soon acknowledged that in both the United States and Britain accident rates had been rising in previous years.[131] A Pandora's box was opened as an unprecedented wave of investigations into industrial safety and compensation took place in many advanced industrial nations. Looking back at the research-based knowledge produced during a half century of social peace, the key European literature review by Hale and Hale would conclude that gross deficiencies surrounded the existing notions of cause and prevention. Confronting the challenge of a new age, they concluded that a great deal more research was required into the effectiveness of prevention techniques and that accident research should generate new techniques; to do this, "radically new theories are needed."[132]

NOTES

1. D. M. Berman. 1978. *Death on the Job.* New York: Monthly Review Press.
2. D. Albury and J. Schwartz. 1982. *Partial Progress: The Politics of Science and Technology,* pp. 9–24. London: Pluto.
3. These figures are drawn from Table 6–3, p. 232.

4. Based on the 1964, 1973, and 1984 editions of the *Encyclopedia of Associations*. Detroit: Gale Research.
5. N. A. Ashford. 1976. *Crisis in the Workplace*, p. 506. Cambridge: MIT Press.
6. In analyzing institutional size I am forced to use the membership data of professional organizations, which, apart from being extremely difficult to obtain for countries other than the United States, are of course subject to all sorts of distortions (e.g., the effects of recruitment campaigns). Both factors combined to discourage my early intention to build detailed analyses of comparative rates of institutional growth.
7. H. W. Heinrich. 1959. *Industrial Accident Prevention: A Scientific Approach*, 4th ed. New York: McGraw-Hill. (First published in 1931.)
8. D. Poulot. 1980. *Le Sublime*. Paris: Maspero. (First published in 1870.)
9. A. Cottereau. 1980. Étude préalable, in Poulot, 1980, pp. 7–103.
10. M. Rose. 1978. *Industrial Behaviour*, p. 44. Harmondsworth: Penguin.
11. F. W. Taylor. 1947. *Scientific Management*, pp. x–xi (from the Foreword by H. S. Person). New York: Harper & Row.
12. Rose, 1978, p. 60. See also R. Bendix. 1963. *Work and Authority in Industry*, p. 265. New York: Harper & Row.
13. M. J. Nadworny. 1955. *Scientific Management and the Unions 1900–1932*, pp. 122–141. Cambridge, MA: Harvard University Press.
14. S. Altman. 1976. Growing pains: A portrait of developing occupational safety and health in America. *Job Safety and Health* 4(8):24–32 (p. 28).
15. L. De Blois. n.d. (1931?) How the Safety Movement Began, p. 6. Unpublished manuscript held in the library of the National Safety Council, Chicago.
16. This development process was the opposite of that identified by Graebner in the United States coal mines; there, development was seen as a result of an employer-worker struggle. W. Graebner. 1976. *Coal Mining Safety in the Progressive Period*, p. 72. Lexington: University Press of Kentucky.
17. D. F. Noble. 1977. *America by Design*, p. 290. Oxford: Oxford University Press, quotes Magnus Alexander, a corporate reformer and former chairman of the safety committee at General Electric, who said at the First National Safety Council convention: "there is a great deal in the relation of employer and employees in improving the welfare of our employees that our employers ought to do and must do, and unless they wake up and go to work and do it soon voluntarily, with all the wonderful effect that it will have on such relationship, legislative action will force them."
18. Noble, 1977, p. 289.
19. Heinrich, 1959, pp. 415–416.
20. De Blois, n.d., p. 6.
21. H. W. Mowery. 1917. Cause and prevention of industrial casualty. *Industrial Management* 53(May):177–189.
22. H. W. Heinrich. 1950. *Industrial Accident Prevention: A Scientific Approach*, p. 17. New York: McGraw-Hill.
23. Heinrich, 1959, pp. 48–49.
24. E. Freidson. 1970. *Profession of Medicine*, p. 255. New York: Dodd Mead.
25. "Enormous progress is made by resolving the safety-productivity conflict; when this is not possible increasing the importance of safety can be attempted, but the success will be less clearcut and more fragile," in J.-M. Faverge. 1967. *Psychosociologie des Accidents du Travail*, p. 30. Paris: Presses Universitaires de France.
26. F. E. Bird and G. L. Germain. 1966. *Damage Control*, p. 21. New York: American Management Association.
27. Bird and Germain, 1966, pp. 69–70.

28. Bird and Germain, 1966, p. 101. "Careless Carl" and "Horseplay Harry" are two in a series of grotesquely stereotyped cartoon workers who destroy forklifts, products, and workmates.
29. J. Tye and K. Ullyet. 1971. *Safety Uncensored*, p. 153. London: Corgi, refer. to "much gossip and ill-informed comment in union circles" that followed a pro-damage control statement by Tye; the authors also anticipate opposition on the grounds of "anti-Americanism."
30. D. T. Hardie. 1981. The safety professional of the future. *Professional Safety* 26(5):17–22.
31. D. Cooper-Richet. 1985. Les ingenieurs des mines vus d'en bas, in A. Thépot, 1985. *L'Ingénieur dans la Societé Française*, pp. 153–164. Paris: Editions Ouvrières.
32. S. W. Malasky. 1974. *System Safety*, p. 7. New York: Hayden.
33. E. J. Henley and H. Kumamoto. 1981. *Reliability Engineering and Risk Assessment*, pp. 1–3. Englewood Cliffs, NJ: Prentice-Hall, introduce some of these notions.
34. International Labour Office. 1989. *The Organisation of First Aid in the Workplace*. Geneva: International Labour Organisation. (Occupational Safety and Health Series No. 63.)
35. V. Walters. 1982. Company doctor's perceptions and responses to conflicting pressures from labor and management. *Social Problems* 30(1):1–12.
36. C. Selby quoted in Berman, 1978, p. 97.
37. A. Hirschman. 1970. *Exit, Voice and Loyalty*. Cambridge, MA: Harvard University Press.
38. Berman, 1978, p. 99.
39. M. Juffe. 1980. *À Corps Perdu*, pp. 58–69. Paris: Seuil.
40. J. T. Carter. 1985. Fifty years of medicine in the workplace. *Journal of the Society of Occupational Medicine* Jubilee Issue, pp. 4–22. On p. 19 an "upstart group" is accused of activities "at worst economically threatening and at best a nuisance."
41. S. Bagnara, M. Biocca, and D. Mazzonis. 1981. Trends in occupational health and safety policy in Italy. *International Journal of Health Services* 11(3):431–450 (p. 438). I. Oddone. 1977. *Ambiente di Lavoro*, pp. 63–64. Rome: Editrice Sindacale Italiana. A. Milanaccio and L. Ricolfi. 1976. *Lotte Operaie e Ambiente di Lavoro*. Turin: Giulio Einaudi. Guilo Gino interviewed by G. Bonazzi; unpublished, October 1983.
42. D. Walsh. 1987. *Corporate Physicians*, pp. 176–179. New Haven, CT: Yale University Press. This study, which came to my notice shortly before going to press, focuses on concerns quite different from those in this chapter.
43. A. R. Hale and M. Hale. 1972. *A Review of the Industrial Accident Research Literature*, p. 15. London: Her Majesty's Stationery Office.
44. P. Desmarez. 1986. *La Sociologie Industrielle aux États Unis*, chap. 3. Paris: Armand Colin. L. Baritz. 1965. *The Servants of Power*, chap. 6. New York: Wiley.
45. H. M. Vernon. 1937. *Accidents and Their Prevention*, pp. 325–328. New York: Macmillan.
46. Berman, 1978, p. 23.
47. Ashford, 1976, pp. 109ff.
48. A. Mintz and M. Blum. 1949. A reexamination of the accident proneness concept. *Journal of Applied Psychology* 33(3):195–211.
49. T. A. Ryan and P. C. Smith. 1954. *Principles of Industrial Psychology*, pp. 480–486. New York: Ronald Press, cited in Ashford, 1976, p. 110.
50. R. Sass and G. Crook. 1981. Accident proneness: Science or non-science? *International Journal of Health Services* 11(2):175–190. E. C. Wigglesworth. 1978. The fault doctrine and injury control. *The Journal of Trauma* 18(12):789–794. F. P. McKenna. 1983. Accident proneness: A conceptual analysis. *Accident Analysis and Prevention* 15(1):65–71. J. B. Cronin. 1971. Cause and effect? Investigations into aspects of industrial accidents in the United Kingdom. *International Labour Review* 103(2):99–115. W. Crawford. 1973. Accident proneness—An unaffordable philosophy. *Australian Safety News* 44(4):11–15.
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tions of industrial injuries. *Journal of the American Medical Association* 186(3):113–119. S. Arieti. 1966. *American Handbook of Psychiatry,* pp. 588–601. New York: Basic Books, cited in Berman, 1978, p. 23.

52. D. Eva and R. Oswald. 1981. *Health and Safety at Work,* p. 65. London: Pan.
53. H. M. Vernon. 1918. *An Investigation of the Factors Concerned in the Causation of Industrial Accidents.* Health and Munitions Committee Memo No. 21, London, His Majesty's Stationery Office, cited in Hale and Hale, 1972, p. 47.
54. W. Baldamus. 1979. Alienation, anomie and industrial accidents, in M. J. Wilson (ed.), *Social and Educational Research in Action,* p. 130. London: Longman/Open University Press.
55. J. A. C. Brown. 1954. *The Social Psychology of Industry,* pp. 266–270. Harmondsworth: Penguin.
56. See A. J. McIvor. 1987. Manual work, technology and industrial health, 1918–39. *Medical History* 31:160–189, for an interesting analysis that includes reflections on differential company demands for "modern" health-related practices created by the Industrial Health Research Board.
57. A. Chapanis. 1983. Human engineering, in International Labour Organisation. 1983. *Encyclopaedia of Occupational Health and Safety,* p. 1062. Geneva: International Labour Organisation.
58. G. Ribeill. 1980. Le débuts de l'ergonomie en France à la vielle de la Premiére Guerre Mondiale. *Mouvement Social* 113:3–36.
59. A. Laville. 1976. *L'Ergonomie,* p. 16. Paris: Presses Universitaires de France.
60. Anon. 1961. Ergonomics: The scientific approach to making work human. *International Labour Review* 83(1):1–35 (pp. 26–31).
61. Laville, 1976, p. 116.
62. M. de Montmollin. 1982. L'analyse du travail, l'ergonomie la "qualité de la vie de travail" les Américains et nous. *Le Travail Humain* 45(1):119–124.
63. One strong index of this is de Montmollin's judgment that J.-M. Faverge, highly influential in continental Europe, was a thinker whose influence "was never felt in the United States." See de Montmollin, 1982, p. 120.
64. The analysis of Brazil is based on personal observation. A. Laville, in personal correspondence of November 7, 1984, discussed the Japanese situation.
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67. T. G. Ison. 1967. *The Forensic Lottery.* London: Staples Press.
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69. Juffe, 1980, p. 29.
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71. Berman, 1978, p. 64.
72. Berman, 1978, pp. 16–17.
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74. R. Lubove. 1986. *The Struggle for Social Security, 1900–1935,* p. 59. Pittsburgh, PA: University of Pittsburgh Press. (1st ed. 1968.)
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76. Juffe, 1980, pp. 26–33.
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132. Hale and Hale, 1972, p. 81.

3

A Sociological Theory of Industrial Accidents

The heart of this chapter is an attempt to follow Hale and Hale's demand and build a new theory of industrial accidents. To do this, it has been necessary to "reassemble" the sociology of work in such a way that it can be used to understand a series of analytically separate, yet empirically interlinked, social relations in the workplace. The new comprehension is formulated to be sufficiently abstract to lend itself to the analysis of the production of a variety of errors within organizations. Subsequent to this formulation, a specific treatment of accidents takes place. The theory conceptualizes that peoples' relationships to their work are managed through social relations of work and that these exist at three levels in the firm—rewards, command, and organization—as well as a nonsocial individual member level. Accidents, which are taken to be a specific case of organizationally produced error, are seen to be produced through the functioning of these levels. Both the accident literature and personal field research are mustered to provide empirical backing for the theory developed. Through the evidence gathered, and through deduction from the theory, a series of hypotheses pertaining to work accidents are constructed, social relation by social relation. Subsequent to detailed discussion of the theory, some general and more abstract hypotheses are made that will guide empirical research. Such is the scope of the main body of the chapter.

The theory of work is essentially a synchronic one. It is obvious, however, that all workplaces come into being as a result of diachronic processes. The introductory section will outline the sociological theory, first placing it against a background of a series of reflections and insights drawn from the previous two chapters, and subsequently turning to an

elementary discussion on a sociology of accidents that will give, if one likes, a bird's-eye view of the topography of the theory by pointing out a few valleys and hills. A series of reflections on the relationship between synchronic and diachronic analysis will be drawn in a final set of introductory points.

INTRODUCTION

Diachronic Analysis

Transformations in the Spheres of Culture, Information, and Interests

In this chapter, the workplace will be a central focal point, whereas in the previous two chapters it was of but secondary interest. In Chapter 1, British coal mining was initially portrayed, with a concrete example from 1583, as being carried out in modest-sized, open-cast mines, with work conducted in small homogeneous groups. By 1662, some mines had grown sufficiently for industrial action to focus on safety. Changes in three spheres appear to have occurred: (1) the increased scale of mining and its move underground required the generation of new information about the work environment to permit workers to execute their tasks; (2) members of social worlds with quite different cultural traditions, worlds that had hitherto been separate, entered into interdependent (although unequal) relationships and started to build what would become industrial society; and (3) conflicts of interest emerged. Such transformations culminated in a phenomenon unthinkable in sixteenth-century England: the great mining disasters of the first decades of the twentieth century. They also led to the escalation of professional and state interventions in the name of industrial safety and compensation.

Information. The growth of industrial capitalism in British society was accompanied by an increase in the information necessary to guarantee the execution of work. This is evident if one considers the transformation from open-cast to underground mining, or the transformation from human and water power to steam and electricity. Through investment, industrial employers sought to obtain those technical and scientific resources necessary to ensure the completion of work and the furthering of their interests. They also sought the products generated by new knowledge in order to remain competitive. Workers acquired new capacities to deal with information and skills in an environment where modern occupations emerged and others were transformed or destroyed.

Culture. E. P. Thompson, in *The Making of the English Working Class,*[1] discusses the transformation of peasant, laboring, or craft workers' identities and separate local cultures into those of industrial workers. The bringing and knitting together of workers around common issues in industrial society and their uniting through conflict, which not only defended their traditions and interests but constructed a new model of society and of social identity, constitute central themes of this work. When looked at as classes in formation, industrial workers and capitalists come to share a common field of action and both will come to define themselves positively in relation to the progress of industrial society; it is this that makes their interrelationship sociologically analyzable.

This being said, however, they are far from sharing the same culture. This can be seen clearly in the development of class struggle and through different views held by actors of social life. Thus, regarding accidents, we see that workers organized lavish funerals, formed self-protection societies with what might today appear to be peculiar rites and customs, formulated their own humanistic visions of science and progress, forged views of autonomy, and held to their visions of truth and justice. Employers opposed such funerals, distrusted self-protection societies, believed that science should serve a form of progress measured in terms of individual profit making, formulated views of control, and sought to undermine workers' visions of truth and justice.

Interests. The expansion of the body of information necessary to perform work and the combination of hitherto separate social categories in workplaces are phenomena that are inextricably interwoven with a profound transformation of the notion of interest. Weber portrays an important image of this in *The Protestant Ethic and the Spirit of Capitalism.*[2] Thus, capitalists would search for profit, and by doing so in different ways would enter into conflict with each other. However, the central conflict of industrial society opposes capitalists to workers. As the workers develop new ideas about their interests and through their search for higher salaries and piece payments, a shorter working week, retirement funds, and compensation, they express interests that are frequently antagonistic to those of employers.

But interests can never be defined only in economic terms. In the area of industrial safety, we saw that workers' defense of their own lives led to conflict with employers, and for the employers the workplace was full of indiscipline. Such lack of discipline clashed with their interests in continued production and economic gain. As industrial society grew, notions of interest transformed themselves, and consequently, the

sources of conflict and the arenas where these were fought were continually displaced. Mechanisms, from safety legislation to collective bargaining and national wage awards, were created to channel and resolve such strife. These mechanisms would frequently seek to redefine all employer-worker differences as conflicts of interest.

The Birth of Institutions

It is in the spaces opened up through society's action upon itself in these three spheres that institutions characteristic of industrial society emerge. Some seek to bypass the idea of conflict of interest or of cultural differences, and they do this by legitimating their activities with reference to their superior competence in the sphere of information. The Weberian notion of legal-rational authority is a construct that is pertinent to the emergence of this phenomenon. Diverse institutional interventions emerge in which activities that serve interests are legitimated by reference to the superior capacities of actors to manage specialized information, to determine appropriate investment in the productive forces, to organize, and to coordinate work. Institutional interventions pound a wedge through the workplace and the society. Thus, cultural orientations are attacked as ideas issued from the institutions are presented as facts and counterposed to worker conceptions of truth and justice, which are delegitimated and often dismissed as serving irrational interests. However, actors within the institutions, even as they seek to apply their specialized knowledge, come to develop their own interests and, frequently referring to ethics, engage in the construction of their own identities as "professionals," "public servants," and "scientists." In so doing, and as societies transform themselves, new foci of conflict emerge. Such an observation cannot be permitted to distract us from the central goal of this chapter. Institutional intervention in the workplace, whether concerning accidents or other phenomena, produce effects, a number of which are perverse, and it should be possible to relate these to the sociological theory to be built.

Some Bases to a Theory of Accident Production

Before moving on to a discussion of the question of perverse effects, let us swoop down from the dizzy heights of such diachronic and macrolevel visions to briefly examine some of the bases of the theory of the production of accidents.

To do this, let us locate the workplace in relation to the arenas that have been subjects of the previous discussion. The location of the work-

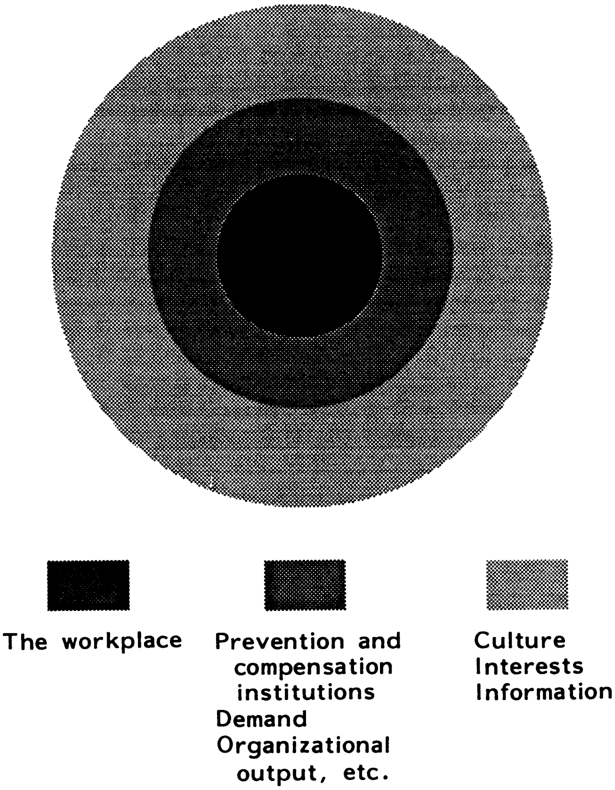

Figure 1. Relationships between arenas of social life.

place is depicted in Figure 1. Each of the three arenas, represented as we change levels of abstraction by increasing intensity, has a capacity to transform itself endogenously, as well as through its relationship with other arenas. At the most abstract level of analysis are to be found the spheres of culture, interests, and information. These three spheres interact among themselves; they can also traverse and penetrate all aspects of social activity. The next arena of analysis is "caught between" this most abstract arena and the one where we find concrete workplaces. It is acted upon and acts upon both arenas. Thus, to take a concrete example, through the action of compensation and prevention institutions, the intermediate arena's operation contributes to transformations of workplaces and notions of interest, information, and culture. The arena can also be seen as capable of internal transformation through its interaction with other arenas (as in Chapter 2, safety and compensation

institutions were depicted as being transformed through conflicts, innovations, and changes in demand). The workplace can be viewed as a condensation not only of external forces and inputs that are assembled within it, but as endowed with a capacity to transform these and in this way produce both an internal life and outputs. Such outputs cannot be reduced to mere responses to the external world, to demands. Rather, from strikes to accidents to goods and services, they may contribute to the production of new institutions, demands, notions of interest, of culture, and of information.

Toward Synchronic Analysis

The exercise of theorizing a sociology of accident production and prevention begins to appear like the composition of a choreography of the movements of social actors as they seek to both defend and to act in terms of their culture, interests, and information within both society and workplaces.

At a microlevel, some of the literature permits such an idea to be explored more specifically and thus allows relationships to be traced between various macrolevel considerations and a sociology of work accidents that is to be applied synchronically.

Empirical Studies of Accidents

North American Indian high-steelworkers erect girders in the construction of skyscrapers and do so without protection; anthropologists have analyzed their acceptance of such dangers as a mechanism through which they maintain their traditional cultural values in an industrial society.[3] These values happen to coincide, not with the values of employers (who would hardly volunteer to do such work), but with employers' interests in having the job done at the lowest cost. What do employers do when workers resist performing tasks which they define as dangerous? The accident near Workington, discussed in Chapter 1, showed employers pressuring miners or paying them extra to work. However, the opposite can also be found where employers try to impede the performance of dangerous work. This was observed with the high-steelworkers who, acting in accordance with their values and eager to affirm their identities as braves, occasionally sought to perform tasks that employers saw as contrary to their interests.

Haraszti powerfully relates the constant risk taking by workers from a Communist factory who are favorably oriented toward earning extra salaries from the piecework system. In such a case, employees link their

own financial interests to danger.[4] Graebner discusses a different relation to danger, one formed through ignorance whereby workers imagine that a factor that is safe is unsafe, and a factor that is unsafe is safe.[5] In such a discussion, the capacity of workers to obtain knowledge of the workplace and their capacity to validate this in an autonomous manner is at stake. Fitzpatrick provides the final insight for this brief overview: for reasons that may relate to the protection of group identity or to the interest of each in protecting one's own life, miners are pictured as not permitting their workmates to act unsafely.[6]

The first insight to emerge is that workers and managers (as employers' agents) are involved in a relationship that leads to workers exposing themselves to risk, and as a result to this exposure, concrete accidents are produced. We have also seen that workmates and managers may try to modify such exposure. A second insight is that the above examples portray a variety of distinct manners through which workers' relationships to the dangers of their job are managed. *A social relation of work is the manner in which workers' relationships to their job is managed.* Such insights, when developed in a manner compatible with knowledge acquired from the sociology of work, will permit the creation of a theory that sees accidents as being produced by social relations. It is to an outline of this that we shall now turn.

Elements of a Theory: A Bird's-Eye View

A first level of analysis can be called the rewards level. The utilization of incentives to manage peoples' relationship to their work is seen in the case of the mining accident near Workington, among the workers discussed by Haraszti, and among the high-steelworkers. In each of these cases, inducements, whether symbolic or material, are distributed in return for the performance of dangerous work.

The resort to stimuli by employers in an attempt to encourage performance takes diverse forms. These are discussed in management literature on work incentives and in sociology.[7] A change in the cultural conception of time has been analyzed by Thompson as being one historical precondition for the operation of modern financial incentive systems, which require the forging of a link at a cultural level between time and money.[8] The complexities of building rewards systems that workers might see as meaningful and the attempt to link worker interests to high performance are among the items considered in management literature relating to this level. The rewards level is of particular interest to sociologists since the sociology of work was born with Roethlisberger and Dickson's discovery that workers engage in "restriction of output,"

which is seen as emerging out of a collectively constructed will expressed as a desire to retain control over employment levels and the "rate" per piece.[9]

A second level of analysis relates to the state of workers' knowledge about their task. A lack of knowledge, as Graebner has suggested, can lead to an incapacity to perform a task safely. Such incapacity may be related to the state of training, the inadequacies of translation of "formal knowledge" into "practical knowledge," or faulty task conceptualization and coordination. From Taylor to Braverman, division of labor, task structure, and task integration are subjects that have received a great deal of attention from management theorists and sociologists.[10] Analyses of factors such as these relate to what shall be called the organizational level. Given the strategic importance of this level in industrial work, it is unsurprising that, of the three social levels isolated here, it is by far the most widely discussed in both management and accident literature.

A third level can be identified. In the literature examined we saw power being mobilized by both workers and managers as a resource to combat behavior perceived to be undesirable. Thus, employers intervene and threaten to punish those who execute work judged overly dangerous, but at other moments employers can be found using the same techniques to pressure workers who refuse to act dangerously. Fitzpatrick has introduced the idea that workers, too, have power, and that they use it to control the behavior of their peers.

Management literature, when it refers to discipline, discusses the use of power as a resource to assure production. Gouldner, through his deliberations on punishment centered bureaucracies, is one sociologist who attempts to analyze this phenomenon.[11] However, sociological literature discusses this level, which shall be called the command level, less frequently than the other two levels.

A further level of reality that is prominent in the literature on accidents is called the individual member level, and some psychologists would see it as responsible for all of the unsafe work that has just been examined. It will be explored later in the chapter.

Summary

The discussion so far is supported by a key notion: that superior and subordinate organizational members engage in struggles over the diverse ways in which the latter's relationship to the organization and its tasks are managed. That task dangers in industrial organizations, which pit employers against workers, are but one stake in this conflict is shown

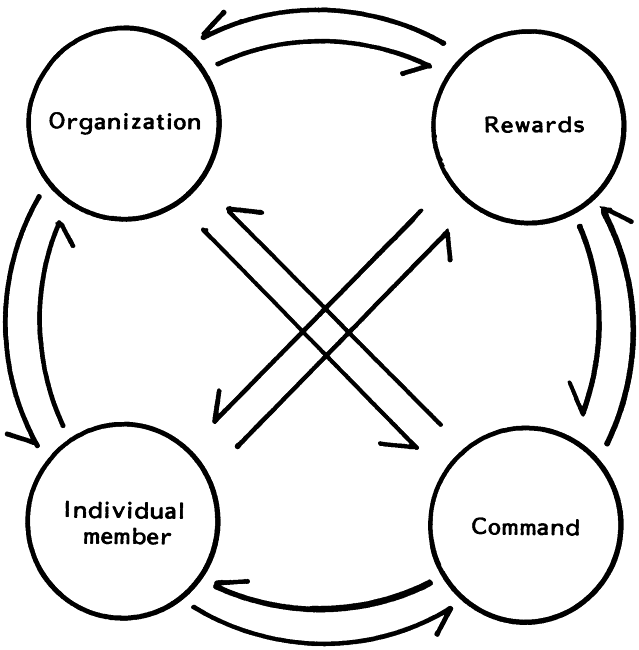

Figure 2. The workplace and interrelationships between levels.

by the literature examined. These reflections lead to the following formulation: that the social conflict between workers and employers for control over the manner in which the workers' relationship to work is managed takes place at three levels, which shall be called rewards, command, and organization. The importance that each level has in the management of work, and the importance of the individual member level, is a function of the state of control and conflict in the workplace. This importance is not given a priori; rather, it is built up in the workplace, can vary from one moment to the next, and through such variation any or all levels may come to play a role in managing workers' relationships to their work. The importance of a level is not given in advance; it is to be ascertained by empirical studies. The three levels at which social relations are conceptualized can be seen as constituting basic building blocks of a sociology of work, ones that can be used to analyze a wide range of phenomena in an enterprise.

The workplace, its levels of reality and logically possible interrelationships between them, is depicted in Figure 2. It can be seen from

the diagram that the term "level" does not imply the existence of a hierarchy.

Synchronic Meets Diachronic Analysis

Building a Workplace

Apart from bringing workers and employers together, each workplace unites a complex range of inputs that are brought in from the outside in such a way as to ensure performance. These include technology, laws, market conditions, specialist professionals, raw materials, and managers.

A sociological perspective on any such inputs demands that explanations of their roles be sociological; that is instead of seeking to explain the social by the economic, the technical, or other nonsocial forces, such inputs should be seen as social products. In response to this demand, I consider that all that comes from outside of the workplace, and is therein assembled as inputs, to be *transformed social relations*. Each is socially produced outside the workplace and then "articulates" within it on the basis of the working through of work relations. I will elaborate: such production and assembly are studied in a systematic way by various disciplines such as history, political science, and management studies and subareas such as political sociology and the sociologies of law, science, social movements, and social stratification. Chapters 1 and 2 drew heavily on a variety of social science approaches in attempting to reconstruct a history of industrial accidents from a sociological viewpoint. This reconstruction was undertaken, I will recall, in order to arrive at a new understanding of contemporary institutional treatments of accident prevention and compensation, to situate their inputs into the workplace, and to enable new reflections on the future of accidents. In this analysis the effective investment effect and perverse effects were discovered.

What then do safety institutions do; what is the role of technology, economic development, law, labor markets, or economic cycles in the production of accidents? Most replies assume such factors to be structural determinants and that causal relationships can be established between them and accidents. My own reply, it should by now be obvious, is different: labor markets, economic cycles, technologies, and laws are not structural features of the workplace. They have no meaning and no role outside of their insertion into work relations, and such incorporation can never be assumed to be static since work relations continually reproduce and transform themselves.

One of the greatest challenges in constructing this theory has been to produce a conceptualization of work that is general enough to deal with these and other so-called structural inputs, not by ignoring them nor, worse still, by dismissing them as nonsocial, but by constructing a concept of "social relation" that is sufficiently open so as to permit their incorporation.

Institutions Intervene in the Workplace: The Case of Perverse Effects

When asked what specific modifications safety institutions bring to the world and to the workplace, the answer is that this can only be ascertained by studying their role in history at a societal level and their insertion into the social relations of work at a microlevel.

Let us illustrate by reference to a hypothetical example, one that is absolutely atypical in an industrial society. Imagine that in our roles as safety engineers or inspectors we recommend that safety nets be brought into a construction site to lessen the consequences of falls by high-steelworkers. This would first reduce the likelihood that those working underneath them would be struck by falling persons; that is, it would reduce uncertainty at the organizational level. For the workers, should these be the North American Indians already discussed, such an investment might reduce the rewards that they perceive the job offers in that their chances to engage in heroic behavior would be reduced. Effective investment could be seen to occur where, because of such changes in work relations, accidents were reduced.

However, the high-steelworkers discussed could conceivably invent new activities in an effort to reinject culturally appropriate rewards into their task. In so doing they might suffer accidents. This constitutes the new accident effect.

These two effects and the ineffective investment effect are pertinent to the activities of those who plan interventions in the name of safety and to safety researchers from all disciplines. However, not all the identified effects are of equal interest to them. The noninvestment effect is of interest, depending on how it is socially produced, to safety professionals, political sociologists, and sociologists of work. The accident inequality effect is a phenomenon of concern to those involved in the study of ethics and social justice; when it results in conflict, sociologists may become interested in its analysis. The effect whereby notions of truth and justice are undermined is of great importance for sociology, anthropology, and, as we shall see in highly complex industries, for cognitive psychology. This effect potentially modifies cultural systems, contributes to the destruction of one set of visions of truth and justice

and their replacement through the building up of another, and, in doing this, the relevance of past analyses of accident production and prevention may be undermined in important ways.

Thus, from the viewpoint of the institutions, the social insertion of their interventions is fundamental in determining success or failure. It becomes incumbent to carefully analyze which component of each particular intervention relates specifically to each social relation. As we move toward the construction of a sociological theory, many further elements that should permit new understandings, not only of the actions of the institutions but also of the general phenomenon of accident production, will emerge. By analogy, other forms of error production will come into a new focus.

TOWARD A SOCIOLOGY OF INDUSTRIAL ACCIDENTS

Outline

In this section the theorization of the rewards level will be followed by that of the command and organizational levels. In treating the rewards level a certain sequence shall be followed. (1) The components of the functioning of the level will be introduced. (2) The relation of financial incentives will be examined. (3) The advantages and disadvantages for employers and workers of the management of work through this relation will be discussed, and the notion that this relation produces errors will be introduced. (4) Following the same lines set out for financial incentives, extended work and symbolic recompense will be discussed in turn. (5) Subsequently, social relation by social relation, we will analyze accidents in terms of the theory. (6) A short discussion of the preventive actions of both employers and workers at the level emerges from this treatment. (7) A general hypothesis pertaining to the social relations and accidents at the level is built.

The command and organizational levels will subsequently be treated; to ensure consistency, the same sequence applied to the rewards level will be used. The internal structure of these levels, with three social relations and both employer and worker preventive actions, is the same as found with rewards. The final level to be examined is the individual member level.

To conclude this chapter, adding to the hypotheses developed in the course of previous discussion, a succinct series of very general hypotheses will be generated.

The Rewards Level

The Level's Functioning

Employers seek to influence workers' orientations to their tasks by the allocation and distribution of rewards ranging from money to esteem. Workers, armed with their physical and intellectual capacities, develop orientations to the rewards offered. On the basis of this development, they decide how to act. A key problem for both parties is the maximization of rewards with the least negative consequences. Both rewards and negative consequences are defined with reference to value systems. For employers, the problem may be defined as the maximization of production while guaranteeing product quality, and for workers, the maximization of salaries while protecting themselves from physical exhaustion.

Two distinct social relations—financial incentives and extended work—are extensively discussed in the literature, while a third relation, symbolic recompense, is discussed less.

Financial Incentives

Financial stimulants are offered by employers with the objective of promoting more intensive work. When action is carried out as a result of an orientation that is favorable to the financial stimulants offered, it can be said that organizational members' relationship to their work is being managed through the social relation of financial incentives.

Intensity can be measured in diverse ways, as tons of production or number of pieces per unit of time. More complex definitions may involve measurements of error detection or net volumes of sales. Hospitals, schools, welfare agencies, insurance companies, and courts develop their own specific measures. Financial stimulants take on a wide variety of forms, such as piecework, contract work, fee for service, bonus payments, and profit sharing. Stimulants may be incorporated into wages and salaries or paid unofficially "under the table." Brown and Mottez are among the authors who examine diverse formulae for their application: individual incentive measures are compared to collective bonuses; stimulants that comprise a minuscule part of wages are compared with those that make up total wages.[12] Such discussions lead to practical insights as to how inducements function in practice and may influence management to propose transformation or abolition.[13]

Advantages and Disadvantages. Systems that use financial stimulants are created in an effort to integrate organizational members' fi-

nancial interests and employer interests in meeting production objectives; however, conflicts between the parties are frequently the norm. The major disadvantage of such systems from an employer's viewpoint is that staff frequently neglect those tasks which do not increase their relative pay and emphasize the performance of only those activities that increase it; for example: scaffolding is erected and not adequately tightened, machines requiring maintenance are run into the ground whenever preventive repairs imply downtime which leads to reductions in pay, scrap is left for others to clean, underground coal is mined at the expense of roof propping, production counts are cheated, and where inducements can be earned only with difficulty, tasks are rejected. Employers may decide to reduce payment rates if the financial rewards earned are considered "too high."[14]

The threat of rate reduction may lead to a worker orientation to depress production levels, a practice Taylor recognized as "soldiering" and which here will be called "rate fixing."[15] Other orientations may lead organizational members to refuse altered work habits in spite of the offers of financial stimulants. When this occurs, it can be said that superiors' attempts to manage work through the offering of such inducements are not realizing their objectives efficiently.

Financial inducements thus can be rejected by informal mechanisms; but, in spite of this, trade unions and professional associations frequently may request their formal abolition,[16] and occasionally they may be joined by bodies representing consumers of organizational products. At other times, superior organizational actors may, to paraphrase the title of Brown's book, "abandon piecework."

Reintroduction of financial incentive may occur for diverse motives. In Great Britain, miners' union pressure for higher wages in a context of national wage controls led to a compromise reintroduction in 1977.[17] Writing in the 1970s, Dore observed a general crisis in the use of schemes involving financial stimulants, particularly those administered on an individual basis, in French, German, and British industry.[18] However, Mottez compares the crisis of task work at the end of the last century with the crisis of a post-Taylorian conception of piecework in France during the 1960s. One solution to such crises thus becomes the invention of new systems for linking rewards and efforts.[19]

Negative consequences associated with the use of the social relation of financial incentives are defined in different ways by different actors: employers may deplore poor housekeeping practices, employees decry the unfairness of certain rates, consumers might protest the quality of products. From the viewpoint of each actor, some such consequences may be defined as errors; from a sociological viewpoint, these and relat-

ed negative consequences can be seen as little other than products of the systematic use of this social relation to manage peoples' relationships to their work.

Extended Work

Extended work is a social relation formed on the basis of an entirely different relationship between payments and work. Instead of intensifying efforts, work is extended in return for payment. In this manner organizational members work long hours or overtax their physical capacities. Loosely speaking, four distinct elements can be identified as contributing to the formation of this relation in industrial organizations: worker orientations in response to employer offers, workers' capacities, task demands, and the period worked.

An employer might decide, because of labor shortages, production deadlines, the high costs of hiring new personnel, or other reasons, to expand work time beyond, say, 40 hours a week or to increase task demands. In such cases an attempt is made to modify former workplace norms. As with the offer of financial stimulants, workers may accept or reject such changes. However, the "norm" may be inadequate to ensure what Marxists call the "social reproduction" of employees. For a variety of reasons organizational members may engage in activities outside of the workplace that reduce their capacities within: the househusband or wife who also looks after the family and home; certain Brazilians who, restricted to 40 hours weekly in each job, frequently toil at two or three full-time jobs; farmers' children who look after the land outside school hours; and the "moonlighting" doctor who toils at another paid job before and after "work." In such circumstances the relation of extended work can be produced.

Advantages and Disadvantages. What are the advantages and disadvantages of the management of industrial work through this social relation? First a comment: the "norm" and task demands referred to above as existing prior to intended changes have been produced through social processes and as such may have little relationship to the capacities of those subjected to them. For example, a task might be undemanding and present few difficulties to the "average worker"; however, should the workers be older, Muslims during Ramadan, or Sri Lankan tea pickers with a low hemoglobin count, their reduced capacities compared with the norm developed, combined with the extension of hours, may complicate the process of task completion already made difficult by their extended work. By offering overtime work, employers

can raise production levels without recruiting new labor and investing in new capital.

By recruiting tired housewives or worker-farmers or by scheduling work so as to oblige Muslims to toil normally when the Ramadan fast reduces their capacity to do so, employers simply seek to guarantee uninterrupted production. In such cases, however, the fatigue or incapacity of employees may reflect negatively on task performance, quality, attention given to the task, and errors.

Diverse mechanisms exist to limit the negative effects of this relation. Both unions and employers can agree to restrict moonlighting: the former to guarantee sovereignty and assure workforce unity, the latter to guarantee productivity or quality. Both parties may endorse subsidized meals: unions as a supplement to wages, employers to guarantee that workers' capacities are not limited by nutritional deficiencies. In a less consensual fashion, workers can be found contesting employer efforts to manage through this relation; two examples are the formal imposition of overtime bans and the development of informal mechanisms (from sleeping on the job to absenteeism) that limit its negative effects.

It can be said that this social relation manages work when, for whatever orientation expressed financially, i.e., in terms of the cash nexus, organizational members expand their action beyond their capacities to effectively complete their job. This differs analytically from financial incentives, with which orientations formed in function of the cash nexus lead members to intensify their work performance.

Symbolic Recompense

Symbolic recompense is the third distinct type of social relation found at the rewards level. Here, rewards are not material and are neither offered nor accepted through a cash nexus: esteem, prestige, and status are among the stimulants used in order to obtain work performance whether by its intensification or expansion.

Management may perceive all hierarchical levels in an organization, executives as well as laborers, as susceptible to this type of influence. Indeed, symbolic recompense constitutes a major analytical category among management theorists. From Etzioni to Herzberg,[20] the groundwork can be found that lays the basis for an understanding of the practical uses of motivation based on the management of peoples' relationships to their tasks through this social relation. Thus, the sense of belonging to a "winning corporate team" fills executives with pride, esprit de corps unites a workgroup by conferring an identity that dis-

tinguishes it from others, and status symbols are used to motivate climbs up corporate and blue-collar ladders.

Whether through attempts to add subjective meaning to virtually meaningless tasks[21] or attempts to encourage work activities, offers of symbolic rewards by management either can be accepted or rejected by workers. Workers, too, can set up their own universe of symbolic rewards; two such examples are informal interworkgroup competition and the building of internal "pecking orders." Such recompense becomes a social relation and thereby alters work performance only because there exist shared positive or negative values that are attached to performance.

Advantages and Disadvantages. Personnel management literature abounds with discussions of techniques of nonmaterial motivation. This is hardly surprising since for employers this relation offers one extremely important advantage over the other relations at this level: it can be a very cheap means of obtaining desired results. Also, workers can attain a form of control unobtainable where financial rewards are offered; by building their own systems of symbolic rewards, they can choose the form through which their work will be rewarded.

The fact that workers can build their own systems of symbolic recompense also implies that they can develop their own measures of performance; employers will perceive disadvantages whenever such measures conflict with their performance-oriented criteria. However, most of the disadvantages of management through this relation differ little from those of other relations examined at this level. From the burnout of status-hungry executives to destructive competition between workgroups and the concomitant results for the firm's functioning and efficiency, the relation's negative effects take on specific forms.

The Rewards Level and Accidents

The management of work by these three rewards level relations produces, beyond its inequitably distributed benefits to employers and workers, a range of possible damage for both; industrial accidents constitute one type of damage.

One idea that can be drawn from the initial treatment of the rewards level is that when the importance of a specific social relation in managing work alters, for whatever reason, so too will its capacity to produce problems or, in our specific case, accidents. The specialized accident literature provides confirmation of this notion, and it is to this that we

shall now turn. Such literature must be read with caution since, as has already been mentioned, it is dominated by studies carried out using a structural approach. Let us now examine, social relation by social relation, this literature.

Financial Incentives and Accidents

For a long time, financial incentives have been linked to accidents both by trade unionists seeking job control and by researchers seeking to analyze their role.[22] French sociologist Georges Friedmann observed that bonus workers frequently find themselves in situations where they must work fast in order to earn a decent wage. Consequently, they abandon the use of personal safety equipment (gloves, masks, glasses, etc.) which might interfere with their attaining a high production speed.[23]

A 1953 report by the International Labour Organisation went far beyond Friedmann in its considerations on the relationship between piecework and accidents.[24] Two Swedish "before-and-after" studies provide some quantitative evidence of the importance of financial stimulants in the production of injuries. In the mining sector a spectacular reduction in serious accidents to 5 percent of their former level was achieved over a three-year period. This occurred subsequent to the acceptance of workers' demands, which had been the subject of a long strike, of which demand for the abolition of payments by results was primary. Less severe accidents fell to 30 percent of their former level.[25] In the forestry sector another study reached a similar, although more modest, result. Accident records relating to 430 loggers were researched and interviews conducted. After abolition of a payment-by-results system, accident rates per million hours dropped by 30 percent and the measure of the number of days lost per accident (the severity rate) fell by a similar amount. In this study the researchers controlled for the effect of this change on work performance, and it was not seen to have been responsible for the observed reduction in accidents.[26]

Wrench and Lee examined British factories, and through an interpretation of daily accident trends concluded that accident rates rose precisely on the days when weekly piecework payments were calculated; they saw this as a negative effect of piecework.[27] A Belgian study by Olivier noted an increase in dangerous activities by coal miners after the introduction of a system of financial inducements.[28] An experimental study of 40 power press workers by McKelvey and his team found that financial stimulants for increased production may also increase accidents.[29] Cheradame compared the activities of trained apprentices on

both ordinary paid work and piecework and found them to be less attentive to their training when on piecework.[30]

Financial stimulants can take different forms. Under-the-table payments can be made to those who perform dangerous work. When I was employed as a construction laborer, these proved sufficient to induce me to work on a swinging stage that was buffeted by high winds and consequently to suffer a "near miss" accident. The amount of time workers have to remain in the workplace in order to earn their daily wages can be linked, under a "job and finish" system, to the completion of defined tasks. On a New Zealand construction site I researched, this commonly used system was seen by workers as responsible for risk taking. It was also linked to a minor accident in which a carpenter, rushing to finish a task and leave work, hit his thumb with a hammer.[31]

The role of worker orientations has been emphasized in theoretical discussion and the literature permits us to see that these are both fragmented and differentiated. Let us now examine this phenomenon.

In research unrelated to industrial accidents, Roy showed that workers on a piecework system treat each task differently. Workers restricted production in those jobs where efforts they considered excessive were required in order to earn standard financial incentives.[32] The extension of this insight to the area of industrial accidents leads to a tentative hypothesis: that safety-conscious workers would be likely to reduce their speed if allocated tasks were capable of execution only at the expense of increased exposure to danger. Olivier's previously cited study appears to produce evidence contrary to this hypothesis. He found that highly paid pieceworkers, when placed on a difficult task, kept up their previous production rate, and in so doing neglected safety precautions.[33] Like much accident research, however, this study as reported does not investigate worker orientations, and these have been theorized to be a crucial factor for understanding actions, whether in relation to piecework or to other attempts to manage work. Olivier's results, therefore, cannot be seen as invalidating the hypothesis.

The above hypothesis can be inverted: workers are oriented to avoid actions that reduce bonus payments. When safety bonuses are paid in an effort to reduce accidents, victims may be oriented to suppress reporting and thereby retain their bonus entitlement.[34] From here one does not have to jump very far to see that the mere existence of payment-by-results systems may lead to a nonreporting of small accidents whenever the time spent on first aid treatment results in wage reductions. One interpretation of a Swedish experience, where, subsequent to the abolition of piecework the rate of minor accidents rose, confirms the plausibility of such a notion.[35]

The picture, however, proves to be more complex than that extrapolated from Roy. Workers develop their own orientations, and these can affect their actions independently of both job demands and the formula for calculating financial incentives. In one study, older pieceworkers were reported to earn less than their younger counterparts. This difference was explained with reference to their orientations: the older workers were less willing to trade safety against higher production.[36]

Thus far we have seen the complexity that surrounds the process whereby employer offers of inducements are transformed into the management of work through the social relation of financial incentives, and how this relation leads to the production of more accidents by altering the way people relate to the difficulties of their tasks. Some writers, however, go so far as to say that financial inducements have no effect on accidents. Let us turn briefly to them.

Hopkins drew on British and Australian statistics in his examination of the views of miners and union leaders. He concluded that those miners who, in opposition to their leaders, argued that no relationship existed between accidents and incentive systems were correct.[37] Mason's study of British Columbia logging workers similarly concluded that no such relationship existed.[38] What such empirical results indicate (if we leave methodological criticisms aside,[39]) is that incentive systems a priori do not produce accidents. In establishing explanations of the relationships they observe, these writers neglect to consider the role of worker orientations in producing action. Thus, like their opponents who argue the a priori existence of a causal relationship between such systems and accidents, they produce a view that leads to methodological blindness because it relies on theories of social action that are both materialist and mechanistic, and, in so doing, leads to the production of "understandings" on an erroneous basis.

What conclusions can be drawn from this discussion? Evidence initially presented suggested that the mere abolition of financial inducements would automatically result in reduced accident rates. This idea quickly showed itself to be simplistic. We saw that similar inducements applied to different tasks could meet with varied treatment from workers. Within the range of possible outcomes, nothing makes accidents an inevitable consequence of the offering of financial inducements. If the management of workers' relationships to their task dangers is modified by their acceptance of financial inducements and if this modification takes place in such a way that workers expose themselves to increased dangers, then the social relation of financial incentives will produce accidents.

Extended Work and Accidents

Extended work is a social relation that, because of its complex origins and different manners of presenting itself in the workplace, is more difficult to study empirically than the relation of financial incentives. The simplest observable form of management through extended work is that which occurs when long hours are worked in one workplace. A French study showed that more than 40 percent of a sample of accidents researched happened to workers who toiled over 50 hours per week.[40] In a Brazilian study, 52 percent of accidents happening to metalworkers were produced when they were on overtime.[41] Contemporary studies such as these reinforce a notion widespread in the leading industrial nations during the early decades of this century that extended work is a major cause of accidents.[42] A series of studies during World War I in British munitions factories provide more subtle empirical observations. A simple semiexperimental study showed that a decrease in the workday from 12 to 10 hours was followed by a 25 percent reduction in accident rates.[43] Vernon established a more spectacular result; when the work week was increased from 60 to 72 hours, accidents increased two and a half times.[44] Powell and his colleagues linked accidents to a complex interaction of fatigue and monotony.[45] Hale and Hale's review of research literature led them to state that the link between the extension of working hours and a disproportionate increase in accidents is conclusively established.[46]

It was theorized that the number of hours worked within a single firm is not the only phenomenon capable of producing the social relation of extended work. The demands of any activity outside of the firm, from housekeeping to moonlighting, can reduce capacities. Vernon observed that an increase in the working day from 10 to 12 hours resulted in accidents rising more for women than for men. This could at least in part be explained by the double role of women as factory worker and houseworker, whereas men primarily have but one role.[47] Further, this finding stimulates reflection on the social insertion of differences in the "natural" capacities that a worker brings to the job. When the working day increased from 7.5 to 8 hours, Vernon and Bedford observed a disproportionate increase in the accident rates suffered by older miners, an increase interpreted as due to the effects of the ageing process.[48]

Further empirical studies strengthen the understanding of worker capacities. Complaints about poor sleep are a significant variable in predicting accidents, multiple accidents, and severity.[49] It seems obvious that hunger or malnourishment reduce capacities, and this has been

researched in a semiexperimental form. Muslims in advanced industrial countries who fast during Ramadan are generally obliged to execute their normal tasks in spite of inadequate nourishment. Grand and Laurent found that during Ramadan the accident rate for the predominantly Muslim North African construction workers in France rises from 3.5-4.0 to 5.5 per 100.[50]

A third dimension of extended work is that of task demands. The greater the psychological and physiological demands of a problematic task (and here this means a dangerous task), the greater would be the expected effect of any extension in hours, or reduction in worker capacities on the impact of extended work and its associated accidents. Solins examined national French accident statistics and found that

> in the construction and clothing sectors there appears to be no link between the length of the working day and level of risk. . . . in the metalworking and woodworking sectors the two accident severity rates are clearly and positively affected by the length of the working day, an increase of one hour involving a rise of 30 percent for the metalworking indicators.[51]

Extended work is produced in complex manners, and its role in the workplace can be reduced in a number of ways. Employers may engage in strategies such as rigid preemployment screening and random follow-up so as to ensure the selection and continued employment of staff with optimum capacities. They may also provide nutritious meals to correct dietary deficiencies or a company transportation system as a substitute for time-consuming public systems. Specific strategies such as the reduction of working hours, or the rescheduling of work during Ramadan might be resorted to as appropriate. Workers may seek to reduce the role of extended work through action taken in either formal or informal manners. Union-backed overtime bans, workgroup-sponsored rotation to relieve tired colleagues, and formally justified absenteeism and its unjustified counterpart constitute pertinent examples. Through reducing the impact of extended work through such strategies, it can be hypothesized that the production of accidents attributed to this relation will be reduced.

Symbolic Recompense and Accidents

It should be recalled that this relation, when it manages the relationship of social actors to work, can serve to either extend or to intensify performance. The film, *The Right Stuff,* based on Tom Wolfe's book of the same name, vividly portrays young pilots, eager to be the first to break the sound barrier and then fly even faster, who died by the score

because of their omnipresent ambition.[52] Their work was managed and their accidents produced by symbolic recompense.

Schwartz has recently sought to explain the Challenger explosion as a product of the narcissism that dominated and structured the activities of the NASA team. This was so pervasive a feature of the management of work, in his analysis, that it served to push the shuttle into the skies without due consideration of the dangers.[53]

Anthropological literature provides a further example of this relation. North American Indians, bearers of a cultural tradition that values heroism, are recruited as high-steelworkers in the construction sector. In a modern setting, management, eager to further its interests in having the steelwork on multistory buildings erected at low cost, harnesses their traditional values. In performing this task, the workers' identities as braves and their heroic status are confirmed. Although the literature does not discuss the workers' reactions to investment in safety devices, such devices might well be considered representative of a culture that would undermine their autonomy and capacity to preserve their cultural values. In such a manner employers save money and workers have their heroic "veneer of fearlessness . . . shattered by one or the other's fall."[54]

But the management of work through symbolic recompense can be combated. The high-steelworkers' employers, when they judge a task to be particularly unsafe, sometimes stop their men from executing tasks. In the mining sector, Fitzpatrick relates a constant orientation on the part of coal miners to seek symbolic rewards by asserting their "manliness." He notes that such actions are vigorously controlled by the miners and are strongly censured whenever they threaten to be dangerous.[55]

Sociology still rarely deals with symbolic recompense and its role in the work world, while it is commonly discussed in management studies literature, where theorizing such as that of the human relations school, Maslow or Herzberg have had powerful influences. However, management literature is not noted for its discussion of the role of this relation in the production of errors. Accidents produced by symbolic recompense are treated in management safety literature by reference to the individual member level, as though they were a property of the psychological make-up of individuals. Never does such literature refer to management's routine use of symbolic recompense to guarantee task execution. The fragmentary evidence presented confirms that this relation has a capacity to produce accidents, and that some actors in the workplace may be oriented to reduce this capacity. Such observations suggest that future accident research could be strengthened by subjecting symbolic recompense to much closer investigation.

Rewards Level Strategies for Accident Reduction

The discussion of the operation of the rewards level has allowed us to see that two distinct strategies exist within the workplace to reduce accidents, one emanating from employers and the other from employees. The former can be called *rewards level safety management* and consists of the offering of rewards or the controlling of rewards systems by employers with the aim of reducing accidents. The worker strategy shall be called *autorewards*, where workers attempt to produce safety, not only by controlling the offer of rewards-for-work, but also by transforming orientations toward the rewards offered and thus transforming actions.

Safety competitions constitute an example of a common managerial strategy to use the rewards level to reduce accidents. Accident production at all levels is the focus of such a strategy. Worker orientations may alter as a result of such schemes. In the literature, safety competitions are seen as leading workers to suppress the reporting of accidents to retain their entitlement to the inducements offered[56]; however, worker actions may be modified, thereby leading to reductions in accidents. We have also seen that certain managerial actions, such as the abandonment of piecework and the reduction of hours, may be resorted to. In a symmetrical fashion working-to-rule or rate fixing constitute elements of worker attempts to reduce accident production at this level.

Conclusion and General Hypotheses

The theoretical discussion, when considered in conjunction with the evidence examined, leads to the formulation of the following general hypotheses: the more workers' relationships to the dangers of their job are managed by social relations at the rewards level, the greater will be the weight of that level in the production of accidents. Any relevant reduction of the weight of this level will reduce the proportion of workplace accidents produced at this level.

The Command Level

At the command level employers seek to manage workers' relationships to their work by taking direct control over their actions. The operation of this level produces three distinct social relations: authoritarianism, workgroup disintegration, and voluntary servitude.

Subject to authoritarianism, workers' autonomy for action is so restricted that they act in a manner contrary to their own orientations.

Workgroup disintegration is a relation that can serve as an important foundation for the use of authoritarianism. Thus, workers labor without sufficient knowledge of workmates with whom they are engaged in the same task. Voluntary servitude manages when workers willingly participate in unsatisfactory situations, without making any reference to other levels of social relations or to the individual member level, because of orientations that coincide with employer objectives.

Employers in "modern" organizations may resort to strategies at the command level if they feel that their attempts to manage work through the rewards and organizational levels are unlikely to meet with success. Alternatively, they may do so in conjunction with strategies at those levels. In reality, workplaces are always torn between stability and change. What appear to be enduring social relations may, from one moment to the next, be altered due to employer or worker actions.

Authoritarianism

To ensure that workers act contrary to their own orientations, employers restrict worker autonomy and tasks are performed subject to the social relation of authoritarianism. This relation is backed by an eventual recourse to violence. In its extreme forms this may range from the historical example of threatened execution of slaves to threatened dismissal of employees in advanced industrial societies. In its less extreme forms, authoritarianism relies on threats of punishment or sanction to ensure that workers, against their own orientations, act according to employers' wishes.

Discipline and punishment are discussed in much of the contemporary literature as though they constituted the last available resource in the managerial quiver of techniques.[57] Gouldner, however, in his development of the notion of "punishment centered bureaucracy," suggests that discipline is indeed a routine tool in organization.[58] McGregor's casting of management theory into two ideal types, Theory X and Theory Y, sees that underlying one type of management practice is the assumption that "most people must be coerced, controlled, directed, threatened with punishment to get them to put forth adequate effort toward the achievement of organizational objectives."[59] Historical texts, be they novels, journalistic accounts, or reports from government inquiries, provide grisly accounts of the consequences of authoritarianism for workers. Of one young miner, the 1842 British Children's Employment Commission was told: " . . . on his body [were] from 24 to 26 wounds. His posteriors and loins were beaten to a jelly; his head which was almost cleared of hair on the scalp, had the marks of many old wounds

upon it; one of the bones in one arm was broken below the elbow, and, from the appearances, seemed to have been so for some time."[60]

Workers actively resist authoritarianism through what Hirschman has called exit and voice behavior (see Chapter 2, note 37). When they do this as social actors, their knowledge of the difficulties of the job combines with an orientation that opposes working under such conditions. Autonomy is a key factor for the success of such resistance. Possible resorts are exit, perhaps more readily considered when actors are in a strong position in the labor market, and voice, perhaps more readily considered when workers are collectively organized in the workplace. Where such autonomy is not exercised, employers can ensure performance through the relation of authoritarianism.

Advantages and Disadvantages. The disadvantages of this relation for workers, from the psychological stress brought about by the constant threat of sanction to the loss of personal dignity felt in a situation of powerlessness, are frequently overshadowed by those of another order. The problems, difficulties, and risks to which workers knowingly submit because they lack the strength to oppose them are likely to spill over into the workplace in concrete forms such as errors, breakdowns, illness, and waste. At first sight, the only advantage accruing to organizational members subject to authoritarianism is that, by virtue of their submission, they avoid punishment.

However, employers may resort to authoritarianism to discourage those worker actions which they judge undesirable. Financial incentives may, for example, lead to workers putting themselves or others at risk or result in poor quality product. In the case of increased exposure to risk, it could be simplistically argued that workers are acting against their own interests and employers are benevolent to resorting to authoritarianism to protect them from themselves. Most use of authoritarianism, however, seeks to guarantee the completion of work. The disadvantages beyond errors, breakdowns, and so forth, if worker resistance escalates, may include sabotage, wildcat strikes, or mass defections.

Workgroup Disintegration

The basis of successful opposition to authoritarianism within the workplace is not exit but voice, and collectively exercised voice. The smallest functional unit on the job is the workgroup. It constitutes the social foundation of the cooperation and exchange essential to collective task performance, of any collective attempt to resist direct or indi-

rect employer control of the collective use of voice, and the basis from which identity and collective projects can be constructed. Gouldner's discussion of the importance of worker social cohesion in a gypsum mine develops along similar lines: "the specific instrument which organized and disciplined" worker resistance to management attempts at controlling work through bureaucratic methods "was the miners' informal social cohesion."[61]

The worker's knowledge of the task and of its interdependent features is shared within the workgroup. This is a simple prerequisite for task completion. Such sharing has two components, which can be called functional and social communication. The former interconnects discrete items of technical knowledge and the latter places knowledge in a context of affectivity, feelings, and orientations: in short, a culture.[62]

For those employers who seek to eliminate threats of opposition founded in workgroups, yet do not wish this to impede task performance, a possible strategy lies in an attempt to control communications so that they are limited to their functional components. This can be accomplished through intense supervision of worker communications or the codification of communication into function-specific "languages." In normal industrial settings effective supervision of communications is, from a logistic viewpoint, a problematic affair. However, more modern technology, such as the IBM 37-50, which permits the control and monitoring of both employee movements and conversations,[63] makes it less so.

Advantages and Disadvantages. A reduction of communication to its functional components, in neglect of its social element, can present serious difficulties for employers. This was clearly demonstrated in the 1950s by the work of the sociotechnical school at the Tavistock Institute. One of the school's most famous studies, by Trist and Bamforth, focused on the change from shortwall to longwall mining methods. Absenteeism, conflict, and unexpectedly low levels of productivity followed. These were seen as consequences of the rearrangement of workgroups and the loosening of social ties resulting from the change.[64] In 1963, the book *Organisational Choice* showed that the organization of a group along lines that reflected members' traditions (multiskilled miners, with self-selected groups, equitable task sharing and equal bonus sharing) was associated with a decline in absenteeism, greater work satisfaction, more ordered production, and higher productivity in comparison with a conventionally formed group.[65]

The discovery of such dimensions permits work to be seen as a far more complex phenomenon than simple technical blueprints, which see

it as made up of a division of labor powered by individuals who work and communicate as task performance requires, would have us believe. The recognition that there is a social dimension to work, and that management blindness to this can produce a wide range of difficulties for both employers and workers, is a key theoretical insight of the sociotechnical school.

Workgroup disintegration is often produced by more banal means than changes in work systems or the policelike supervision of communications. The literature suggests that the relation is constructed sometimes in a calculated fashion and sometimes involuntarily.

Management sets out to build workgroup disintegration in specific cases. It acts in terms of perceived advantages of workgroup disintegration when it dismisses those who bring social unity to workgroups (this can be observed in the case of actual or potential trade union leaders faced with a hostile management), and uses a strategy of job rotation to fragment solidarity among workmates. In *L'Établi,* Robert Linhart portrays the case of three immigrant workers who had developed a highly efficient and cohesive workgroup; when this threatened employer power, the group was fragmented even though productivity loss would be a consequence.[66]

Workgroup disintegration, without being an intended consequence of deliberate managerial strategies, can become a negative factor of workplace life. Noise impairs workgroup communication, language differences frequently mean that workers cannot understand each other, high labor turnover, and absenteeism result in groups that never achieve integration; in these and like manners, misunderstandings, poor performance, and other ills can become endemic to the workplace.

This discussion has necessarily been a simple one. In order to combat the relation's disadvantages, employers may resort to techniques designed to stabilize the labor force, develop common communication abilities, or foster collective activities that serve to integrate workgroups. Workers, too, may attempt to overcome the disadvantages they experience with workgroup disintegration through clandestine or visible activities. The development of group slang, for example, may lead to the formation of an integrative "cultural milieu" in the workplace. Trade union organization on the shop floor may introduce political substance to such integration.

Voluntary Servitude

Voluntary servitude is the third distinct social relation at the command level. This relation manages peoples' relationships to their task

when elements of the job known to generate difficulties are treated as forming a normal part of it. In the language used in this theory-building exercise, workers are engaged in problematic tasks, are knowledgeable of the difficulties involved, and, in making no reference to the rewards level, accomplish their task without developing an oppositional orientation. Work in insalubrious environments, considered as "normal" by fatalistic workers, is subject to this relation.[67] Tasks are completed because worker orientations and actions are in harmony with employer objectives.

Herbert Marcuse's *One Dimensional Man,* Richard Hoggart's *The Uses of Literacy,* or Étienne de la Boétie's sixteenth-century classic *Discourse on Voluntary Servitude*[68] are texts that treat this relation in a macrosocial context, one that seems far removed from the concerns of the workplace.

Once our gaze turns to the workplace, historians provide valuable insights into the relations' development as a mode of managing work, and some sociological and management studies literature provides insights into the relation's operation. From the historians we learn that at the turn of this century United States industrial employers were faced with two problems: how to coordinate large-scale and complex production processes and how to calm omnipresent employer-labor conflict. Among the many solutions proposed, one met with great success: the replacement of traditional authoritarian control with bureaucratic control. Power thereby came to be fixed in roles rather than in people, and the organization came to be homogenized and coordinated through formal standards.[69] The bureaucratization of salary systems, work rules, and promotion were seen in Burawoy's historical account to have contributed to a changed pattern of labor-employer conflict in the United States between 1945 and 1975:

> The arena of subjectivity, of conscious resistance to domination, disappears, giving way to the individual as a mere object of manipulation. . . . Activities at work can largely be accounted for in terms of the organization of the labor process, the internal state and the internal labor market. Consent is produced and reproduced on the shop floor . . .[70]

In a synchronic and sociological perspective, Alvin Gouldner delineated two important patterns of bureaucracy, which he called representative and punishment centered. Those procedures that lead to tasks being completed because workers fear punishment have already been defined as a component of authoritarianism. A representative pattern of bureaucracy is one where both employers and workers support and enforce the rules that are subject to few vertical tensions. In such a

system, workers will labor under certain difficulties because the existence of appropriate rules has led them to define these difficulties as "normal" and as "part of the job." In so doing, their work is managed by the relation of voluntary servitude.

For Gouldner, discussing the specific case of safety rules:

> No other ongoing program in the plant had the galaxy of rules, special meetings, posters, inspections, or special supervisors in the main office and local plant. Indeed . . . the only thing that the men in the plant thought of as "rules" were the safety regulations. As one foreman said: "It is the one thing they really work on."[71]

Gouldner went on to distinguish differential degrees of consensus around these rules as a function of the cultural orientations of actors: because the rules were more in line with their middle-class values, they were more readily accepted by surface workers than by underground miners. His sophisticated analysis continues with a depiction of these rules as "an easily justifiable technique for *controlling workers*."[72] Beneath the surface we can see the existence of the conditions for a move from what Gouldner has characterized as representative to punishment centered bureaucracy, or from what has here been conceptualized as a movement from management through voluntary servitude to management through authoritarianism. Such conditions are fulfilled when what for some are "normal safety rules" become redefined as "abnormal controls."

The spread of workplace bureaucratization, the recent expansion of Japanese management methods notwithstanding, is widely seen as a historical trend; however, it is not the only process that can lead to the production of voluntary servitude. Employers may recruit categories of workers judged to have servile orientations, such as women, the physically handicapped, or illegal immigrants.[73] Traditional employers may resort to paternalism to ensure that work gets done. A modern version of this is contained in the theorizing of the human relations school. W. F. Whyte and B. B. Gardner see the building of cooperation between the work team and management as a product of a process in which the paternalistic supervisor plays a key role: "He does good turns for them, unobtrusively, as a natural part of his behavior, and they reciprocate."[74]

Bureaucratization, selective recruitment, and paternalistic practices have been added to by techniques, drawn from industrial psychology, to form the mainstays of a certain brand of managerial theory. For Likert, the aim of management is "to tap the motives which bring cooperative and favorable rather than hostile attitudes" (orientations) and the supervision of this "participation and involvement in decisions is a habitual part of the leadership process." Workers are engaged in a cooperative

enterprise and ideally "pull concertedly toward commonly accepted goals which they have helped to establish."[75] In recent times quality circles have come to occupy an increasingly important role in industry, and industrial democracy has been embraced in many quarters. While the articulation between such practices and work relations needs to be better understood, it is clear that in some cases these practices can be seen, contrary to Likert's ideals, as contributing to the production of voluntary servitude.

Advantages and Disadvantages. This relation might seem particularly attractive to employers since it promises a "trouble-free" workplace, disciplined employees, and consolidated management power. In theory at least workers are reduced to marionettes that move at their employers' behest and willingly so. For their employees, work life managed by this relation becomes "natural."

The disadvantages of this social relation for employers are discussed in management literature. Rules are seen as potentially leading to inflexibility, the recruitment of a passive workforce may also be the recruitment of a workforce that lacks initiative, paternalism may lead directly to personalistic management, and an overemphasis on cooperation may be seen as leading to immobilization or passivity. The negative consequences of such phenomena whereby all difficulties within the workplace, from quality to error, come to be accepted as normal are not hard to deduce. For management the extreme situation can be produced where to guarantee control it must engage in constant supervision and verification, and to do so it can only rely on its own forces.

Those whose work is managed by this relation show, by definition, a noncritical orientation. Unions may see voluntary servitude as undermining their power, critical workers see it as threatening the capacity to forge an identity based on opposition to managerial control, and both parties may attempt to contest it. Union opposition to forms of worker participation and worker opposition to their "apathetic" colleagues are traveling companions of consciousness-raising programs and face-to-face discussions that attempt to break down the employer's capacity to manage through this relation.

The Command Level and Accidents

Authoritarianism and Accidents

Traditional accident research simply ignores authoritarianism as a subject of interest and consequently is unable to treat unionism's role in

preventing accidents through combating it. Studies on the phenomenon are rare and lack both the variety and precision of those found in discussion of the rewards level. To fill this gap, some empirical evidence will be drawn on from my own case study research.

Throughout our discussion, collective worker organization has been seen as a means of combating authoritarianism. What does empirical research have to say about this? Raftery and Akman documented an abrupt threefold decrease in the rate of disaster accident in British coal mines, which occurred shortly after the establishment of the National Union of Mineworkers.[76] Graebner's historical research on coal mining in the United States provides a crude statistical test and, through it, an indication of the validity of the hypothesis that collectively organized workers experience reduced accident rates. Drawing on 1907 data, he revealed that in states without union organization 9.49 work fatalities occurred for every 1,000 employed. This figure dropped to 5.07 in states where unions were partially implanted and, where unionism was fully implanted, the lowest rate of all 2.47 could be found.[77]

In his study of the British North Sea oil fields, Carson concluded that a key factor in explaining the high accident rate found there was that legitimate union power, capable of contesting employer power, was lacking.[78] In such a climate, dangerous work flourished. His writings enable one to observe that social relations at more than simply the command level produced accidents on the oil fields. Expressed in terms of the theory being developed here, Carson's explanation is that a greater degree of worker command power would have contributed to a lessening of the weight of specific social relations in the management of workers' relationships to particular task dangers and, consequently, would have reduced their accidents.

The findings of Raftery and Akman, Carson, and Graebner receive support from Grunberg's cross-national comparative study on automobile plants, which shows that the more strongly unionized British automobile workers have a much lower accident rate than their weakly unionized French counterparts engaged in similar tasks.[79] Turner, Clack, and Roberts' research on the British car industry mentioned that after worker collective power was weakened due to the dismissal of those seen by management as "ringleaders," accident rates rose by 40 percent and working hours lost rose by nearly 60 percent.[80] The Children's Employment Commission's report leads one to understand that authoritarianism, in what were depicted as despotic workplaces, would have regularly produced accidents in Great Britain in the 1840s. In a different context, exposure to danger and an inability to refuse work

were seen as going hand in hand for black South African miners; this link was explained as a result of their being subject to "racial despotism."[81]

It cannot be concluded from these studies, however, that the mere presence of trade unions reduces accidents.[82] In fact, unions can exert a powerful role in making worksites less safe. This was clearly illustrated in some of the Parisian construction sites I researched. There, nonrepresentative, employer-implanted unions were to be found. They effectively hindered any attempts, even spontaneous ones, to engage in collective action questioning safety. Some interviewees saw these "scab-unions" ("bosses unions," they called them) as tools of employer authoritarianism. We shall see, in further discussion of voluntary servitude, that unionists may refer to their role as participants in "representative bureaucratic" structures, and through such reference support the status quo in the face of worker complaints about problems. These observations translate into the following hypothesis: that union action that does not increase workers' collective strength and translate this into voice around safety issues may do nothing to lower accidents.

That authoritarianism routinely produces dangerous work was shown in the French construction sites I researched. Let us look at an example from one site, an extension to the underground railway system where the Communist-oriented CGT (Confédération Générale du Travail) union was implanted and approximately 100 men employed. A laborer was observed working, one foot on a ladder rung, the other some 70 centimeters away on some boxing, with his back turned to the ladder. He was leaning forward, torso twisted toward the boxing and bent over so that his head and waist were at the same level. From this position he executed his task of sawing the boxing which was located some three meters above a solid concrete floor.

"Ask him why he's working like that!" a foreman urged. Once left to myself I took up his suggestion.

"I know what I'm doing is dangerous," the worker replied, "only, I pay attention."

"Why don't you ask for safety equipment?" I asked.

"Because if I did the boss would say no, and then would treat me badly for a while. . . he won't provide safety . . . if I refuse to work here, I could be down the road with the first layoffs, that's why I work like this. You know, I had an accident once, and that resulted in 20 months off work . . . they operated 12 times." He lifted his shirt to display the scars and continued, "They should have never asked me to work like that. I'm afraid of accidents. I know that one could happen

here, but what do you want me to do?" We changed the subject and he replied to my provocation: "If I fall, the bosses will say it's my fault, but it's their fault. . . sure, I'm going to work carefully."[83]

In a New Zealand construction site two unionized apprentice carpenters suffered an accident as a result of their work being managed by this same social relation. They defined themselves as lacking the collective strength to refuse work on a scaffolding plank known to be in a poor state, and the plank eventually broke under their feet. A half a world away, and nearly 70 years earlier, similar difficulties were detailed at the British inquiry of the Building Accidents Committee. "All workmen on a building are capable of judging the soundness of a plank; if the one lying nearest is not suitable they should look for another," stated Mr. Anderson of Glasgow; however, Mr. Matthews of Manchester reported, "If a man complains to his employer [about scaffolding materials], who may be one who provides indifferent material and indifferent scaffolding and all that kind of thing, he would tell such a workman to clear off."[84]

This discussion can be summarized as showing that authoritarianism produces accidents. It has also been observed that trade unionism cannot be operationalized as a structural factor, capable by its mere presence in a workplace of reducing the weight of the social relation and its associated accidents. Rather, the crucial factor in combating authoritarianism appears to be the autonomy that actors have, in function of their knowledge and orientations, to refuse work which they define as dangerous.

Workgroup Disintegration and Accidents

Workgroup disintegration showed some importance in my New Zealand construction site case study. Its formation was linked to both the constant labor turnover rate and changes in group membership among laborers. This relation produced an accident where an ambiguous signal was interpreted by a crane driver who moved the jib in the wrong direction, and a worker's legs were crushed. On-site discussion subsequent to the accident led to the suggestion that a walkie-talkie system be purchased to prevent recurrence. For management the high labor turnover rate experienced precluded adoption of an alternative solution, suggested by Leplat and Cuny, which was the development of and training in a codified signaling system.[85]

In the Parisian sites I researched, immigrant workers from diverse linguistic backgrounds were commonly placed in the same workgroups. Communication difficulties were regularly seen as a barrier to safe working. Wisniewski's study provides a quantitative notion of the impor-

tance of the phenomenon. Workgroup disintegration was isolated as a causal factor in 5.1 percent of all fatal construction accidents in Paris.[86]

In West German coal mines, 8 percent of all accidents were linked to faulty communication, of which the majority were due to lack of communication in a workteam.[87] Neuloh, Rhue, and Graf found, in three German steel mills, that 10 percent of accidents were due to a "communication having been inexact or poorly understood."[88]

Noise is one obvious phenomenon that interrupts functional communications within workgroups. In their literature review, Wilkens and Acton see the masking of warnings by noise, aggravated by the need to wear hearing protectors, in addition to noise-caused hearing loss as factors that lead to an increase in accidents through their role in reducing functional communications.[89]

Thus far, the discussion has centered around faulty functional communications. What evidence exists on the role of social communication? Neuloh and co-workers' finding that accidents are linked to defective communications excludes reference to the character of interpersonal relations; in so doing, it suggests that social communication is unimportant in accident causation.[90] However, Ancelin-Schutzenberger analyzed a number of sociometric studies and concluded that "group cohesion and safety are linked." Group cohesion is based on ties that range from being narrowly affective to broadly cultural. In the absence of such ties disagreements among workgroup members can easily be produced. These will reflect different notions of truth, such as dissimilar appreciations of the state of materials, and different notions of justice, such as disparate views relating to who should be exposed to difficulties and under what circumstances. Many such disagreements may never become explicit; instead, they remain reflected in constant misunderstandings that arise among people required to perform the same task together. In such a manner, problems, including accidents, are produced.

Directly relevant to this discussion of industrial work is some sociometric research carried out among sea-based air squadrons operating in the Pacific during World War II. A squadron that was incurring heavy losses was examined to determine to what extent members flew alongside or were led by their preferred companions. A similar study was carried out in a low-loss squadron. Members of the former squadron flew with few preferred companions and members of the latter with many preferred companions. Ancelin-Schutzenberger reports that changes were made so that the preferences for flying partners expressed by members of the heavy-loss squadron were granted, and a dramatic reduction in losses followed.[91] For those jobs where work rhythms and task interdepen-

task interdependence demand closely knit workgroups, for example, firefighting and the operation of modern chemical plants, such a result appears to be of utmost importance from the viewpoint of error avoidance in general and the prevention of accidents in particular.

Workgroup integration may be undermined through the existence of competition between individuals and groups. However, workgroup integration may be promoted for a number of motives: task dangers may lead, as Yarrow observed, toward strong worker orientations "to keep their buddies' safety in mind."[92] Employers may introduce policies ranging from language training to the favoring of racially integrated workgroups, or they may back the formation of informal or even of trade union organization in an attempt to promote higher levels of integration.

The integrated workgroup provides a simultaneous threat and benefit to employers. For employees its existence is essential. In the first place it ensures the prevention of a certain type of accident. Second, it provides the basis for sharing knowledge, and through such sharing those employer initiatives that are perceived as creating problems can become subject to collective displeasure and eventual challenge. Or, as Faverge puts it, "in a good workgroup each protects the other and avoids involving them in accidents."[93]

Voluntary Servitude and Accidents

Voluntary servitude is a social relation that, when it produces accidents, can be seen as existing in seeming defiance of the first Hobbesian law of nature, which states: "man is forbidden to do, that, which is destructive of his life . . . and to omit, that, by which he thinketh it may be best preserved."[94] Acting independently of any considerations relating to autonomy, workgroup integration, or rewards, workers whose relationship to their work is managed by this relation are not oriented to oppose the risks of their job; this occurs in spite of their knowledge of these risks. Studies that examine voluntary servitude's role in the production of accidents are rare, and these few do so only in passing.

Interlude: Who Goes Down on the Rope? Let us momentarily turn our attention to a historically important case that involved people working with known dangers. In Chapter 1, we saw that workers were lowered into mines on ropes to test for gases. The sociological analysis of "who goes down on the rope" and how this occurs is one that, from firefighters to seafarers, is of considerable importance. The mechanisms that permit some actors to protect themselves from risk at the expense of

others is brought into sharp focus by examining this question. Also brought into focus is the creation of notions of justice that guarantee equality of exposure among workers.[95] Also, the interpretation of changes through time in the criteria used may well reflect important shifts in power and notions of justice. Such analysis, because it deals with a "limit-situation," could cast important light on our understanding of the interrelationship and boundaries between authoritarianism, symbolic rewards, financial incentives, and voluntary servitude.

Research Literature. In their study, *2000 Accidents*, Powell and co-workers noted the existence among workers of a laissez-faire orientation toward certain risks. They explained that workers thought it "part of the job" to deal with them.[96] Certain dangers were seen as "normal" on a number of French construction sites I researched. For example, a laborer had told me that "nothing is missing here with regards to safety." I contested this by showing him the poorly built platforms, traps, and missing guardrails. "That's okay," he replied. "Anyone can fall . . . there will always be industrial accidents."

In the Children's Employment Commission report we saw that a category of worker seemed to passively accept industrially produced death. One worker questioned by Powell and co-workers suggested that, "If you think about all the risks that go with this job, you'll drive yourself barmy."[97] The intense anguish workers feel as they regularly sublimate fears of their jobs' dangers has been clearly revealed in psychopathological research by Christophe Dejours.[98] From a sociological viewpoint, however, such reflections lead one to ask how social relations are constructed that lead to worker acceptance of a job's dangers and to the perception that accidents are things that "just happen"? This question was addressed in an introductory fashion as a result of Edwards and Scullion's factory research, when they explained:

> Safety need not be uppermost in workers' minds. Indeed the very fact that this is so points to the general ethos of production: workers ignore safety matters not through willfulness or ignorance but because they have come to take for granted a different set of priorities.[99]

However, the social construction of this "different set of priorities" remains a mystery.

How, in the absence of a "spontaneous" production ethos, are enduring patterns of voluntary servitude built and maintained? At a global level, Graebner relates that in the United States ideology functions to lead workers to accept that dangerous occupations are a question of "free choice" rather than something to be combated.[100] A number of

methods of building this relation were mentioned in earlier discussion: specific recruitment policies, paternalism, bureaucratic rules, and worker participation. The institutionalization of these and other appropriate methods can serve as a basis for the durable maintenance of this relation's role in managing work.

Voluntary servitude and associated accidents can be produced through worker participation in safety committees. Yet in recent years, such committees have become an indispensable tool in many safety efforts. Through examining this paradoxical state of affairs, one of the mechanisms that surrounds the creation and maintenance of voluntary servitude in organizations can be understood.

Dassa and Maclouf associated the operation of a committee with reduced accident rates. Their study also reported that only a small range of problems could be discussed in the committee setting: work rhythms and task demands were not considered legitimate topics.[101] But what is the point of having safety committees if their agenda excludes certain categorizations or conceptualizations of accident cause? A political answer to this question is found by the authors: the committee's role is "to find a way of bypassing social antagonism."[102] Putting it another way, the committee exists to turn workplace conflict over danger into social peace. To do this, it institutionalizes the treatment of danger in such a way as to have it defined in narrow terms. Thus, specific dangers are reduced as a result of the committee's action, and social relations formerly associated with working with them are modified. In the dynamics that surround committee life, however, worker representatives commonly come to accept those phenomena that are excluded from the agenda as elements about which nothing can be done. They return to the workplace vaunting reforms and defending the idea that other dangers are "normal." Gouldner reinforces this view when he sees safety meetings as an "instrument designed for generating conformance," and mentions their more general role in "sometimes discuss[ing] other subjects having little connection with safety work."[103] Indeed, as we shall see in Chapter 6, research into safety committees leads to grave doubts about their capacity to achieve their stated goal. How then can their role be understood?

It can be hypothesized that employers implant committees for reasons that are not entirely dependent on their role in accident reduction. Some of these reasons are political and reflect an employer orientation to establish institutional mechanisms for the management not of safety, but of complaints about safety. One effect of this, it can be hypothesized, is that the committee becomes a factor that contributes to the production

of a generalized voluntary servitude; as a consequence, associated accidents rise.

Bureaucratic safety rules or standards can also contribute to the production of voluntary servitude; indeed, the more general role of rules in preserving apathy is referred to in the literature.[104] Rules and standards may be formulated within a specific workplace or, as in the case of safety laws or head office instructions, be imposed by external bodies. Employers can decide whether or not to enforce them and workers whether or not to obey them. "Mock bureaucracy" is the term Gouldner uses for rules that are mutually ignored by management and workers under most circumstances.[105] Serious rules, whether backed up by what I have typified as a punishment centered or a representative bureaucracy, have two commonly recognized weaknesses; they frequently lag behind technical and other changes[106] and the minima they decree may be problem inducing.[107] Goldman and van Houten see rules as serving to prevent labor disputes and reduce arbitrary authoritarianism.[108] As we saw in Chapter 1, rules and standards function as a substitute for employer and worker visions of truth. This was read as constituting an attack on workers' cultural tradition. To refresh the reader's memory, this occurs when the worker believes that a particular phenomenon is unsafe, yet the rules define it is safe. The worker's "subjective" definition of the state of affairs is contested by "objective" rules. The initial oppositional orientation can be broken down and the worker is drawn to work that is "subjectively defined" as dangerous on the grounds that "if it's not against the rules, it must be safe."

In the course of my empirical research, voluntary servitude repeatedly appeared to be produced through the application of safety standards. A tragic example of an accident produced by this relation occurred on a Parisian construction site. The victim, working on a plank that was only 15 centimeters wide, lost his balance, fell from a height of 2.7 meters, hit the side of his head on a piece of scaffolding, and died in hospital two months later. Site management interpreted safety legislation as not requiring protection for those working at heights of less than 3 meters and, for this reason, such work was commonly accepted. Subsequent to the accident, wider planks were routinely used to reduce the likelihood of workers losing their balance; this in turn reduced the possibility of such a continued interpretation of the law, and the social relation that ensured such work, producing accidents.

On another site, the same empirical problem that had been associated with the fatal accident was found. Through interviews a clear indication of the links between legal standards and the management of work

by voluntary servitude were established. "Over there, where we've just poured (concrete), there should be a guardrail, but because we're working at 2 meters 70 . . . from 3 meters up we haven't the right to work without a rail, but here we can't ask for one because they'll say it's not required." The interviewee elaborated somewhat before saying, "it's the law that stops us from working safely." The union delegate saw this particular case as part of a more general "problem which we can do nothing about."

There are other "problems" in the workplace that can be controlled by delegates and workers. One category results from worker actions that employers may oppose. Workers can be found increasing the risks to which they are subjected by rejecting protection: removing machine guards, refusing to wear safety equipment, or disobeying safety rules. Commonly, such rejection may be justified because protection impedes reward earning, is considered awkward, or makes the job monotonous. This phenomenon occupies considerable space in management literature and, for this reason, merits analysis in greater depth.

Interlude: Rules, Regulations and their Rejection by Workers. From the beginning, the notion that workers have a cultural tradition and employers have another has been emphasized. One of the preconditions for the building of industrial societies has been the construction of a degree of consensus at a cultural level through which both sets of actors share common elements in their world views; for some writers these elements are referred to as modernity, for others as industrial (as opposed to proletarian or entrepreneurial) culture. In the process of building the cultural terrain that makes industrial society possible, actors also attach themselves to their identities, and they defend their cultural tradition against attacks from other parties. Workers may base such defense on their own conceptions of "truth" which lead, in the case of safety, to certain standards being dismissed as unsafe. One French construction laborer refused to use the safety harness provided for his task. He said that the hooking and unhooking procedures necessary to change one's position were more dangerous than simply not using the harness. (His rejection was formulated without his having any knowledge of a French study which showed that the majority of accidents happened to certain harness users in the course of these procedures.[109]) In a different manner, rejection can take place because protective devices and rules are seen as symbols of "unjust" employer domination,[110] or because they are ugly, impede performance, are poorly designed, and as such are perceived of as an affront to personal dignity and comfort.[111] That certain employers define safety rules that workers see as unreasonable and

tolerate employee bucking of these rules is common in many workplaces.

However, when they reject such "symbols of safety," workers morally disarm themselves of the right to demand increased safety from their employers; this constitutes a political incentive (which adds to possible economic incentives) for some employers to tolerate rule breaking. Such a dynamic appears to have preceded the Appin mine explosion in Australia, where safety devices were discounted by the men who had developed their own "experience-based standards," and at the same time management was tolerant of high levels of gas even though ventilators were out of order. Thus, both sides infringed on regulations; however, only one side would suffer as a result of the explosion—those who had come to accept the probability of gas explosion in their workplace as "normal."[112] Such employer tolerance can in many cases be hypothesized as containing a secondary benefit: it provides confirmation of the notion that workers are careless, and employers are thereby permitted to occupy the moral high ground and relieve themselves of responsibility for accidents. What more can be done, employers might ask. They have made the rules, tried to enforce them, and done all in their power . . . the victim is to blame.

Such an analysis contests the view that sees the rejection of safety equipment and rules as the sole responsibility of workers. An important component of rejection may be the workers' defense of identity against employer attempts to control their actions.

Empirical research is necessary before statements can be made about the orientations and the social relations that manage the work of those who specifically reject safety devices and rules. Clearly, all such action cannot be seen in terms of voluntary servitude. In saying this, I break with the dominant position that seeks to attribute all such actions to the operation of the individual member level.

Concluding Observation. Voluntary servitude is produced in diverse of manners. While the literature allows it to be seen as a category for sociological analysis, the development of a detailed understanding of it is, as in the case of symbolic rewards, limited by the lack of empirical studies that specifically interpret its role in the production of accidents.

Command Level Strategies for Accident Reduction

Two distinct strategies can be identified for accident reduction at the command level that are similar to those identified at the rewards level.

Command level safety management is engaged in by employers to

lower accidents produced at this or at other levels. In previous discussion it was seen that employers could engage in activities such as noise reduction or the recruitment of workers with defined linguistic competence[113] in order to lessen the dangers associated with workgroup disintegration. Employers can resort to command level strategies with the aim of altering the operation of social relations at other levels; for example, disciplining those who work dangerously to earn bonuses or those working outside their allocated tasks. It can be hypothesized that accidents at the relevant levels will be reduced accordingly. In one study, Dassa and Maclouf have specifically linked authoritarian and centralizing management methods to a small decline in what were originally high accident rates.[114] However, it is the articulation of such a strategy into work relations that determines its effects on accidents: disciplinary measures were interpreted by Hale and Hale as probably reducing accident report rates rather than accidents.[115]

A large number of studies indicate that "management involvement" in safety can reduce accidents; however, such findings merit more finely tuned analysis and eventual interpretation in terms of the sociological theory. Since many management efforts take place at the organizational and rewards levels, it is incorrect to assume that all actions that fall under this label constitute examples of command level safety management.[116] Faverge warns that the apparent results of management safety campaigns "are often more important than the real ones" because of their effects on report rates.[117]

Autocommand is the name given to worker actions taken at this level to reduce accidents. When they build integrated workgroups, have knowledge of their job and of relevant factors external to it, and an orientation against working with risks, workers have an ideal basis on which to oppose employer command level pressures. From such a base, they can engage in activities to reduce the weight of accident-producing social relations at other levels. They may sanction workmates who act dangerously. Workers may form, as Trist, Susman, and Brown found, into autonomous groups that are better able to adjust to changed safety requirements than are nonautonomous groups.[118] Their integration and orientations may lead them to demand new investments, better training, or the abolition of financial incentives or overtime work. Such demands may be placed on the negotiating table or, far more rarely, be expressed through wildcat or organized strikes. Edwards and Scullion, in a British factory they named the Small Metals Factory, found safety representatives who were prepared to stop production to back up their demands, and were sufficiently powerful to officially request, and achieve, improved safety.[119]

Employer-promoted safety programs were greeted with skepticism by workers questioned in one United States survey. Over half of them thought employees could best contribute to job safety.[120] This suggests that, in the eyes of workers, autocommand is the best means of achieving job safety. However, such a notion is a political one, and it is compatible with worker interests of achieving greater job control; in pursuing such interests, workers may pay little attention to accident reduction.

Discussion thus far has focused on knowledgeable, safety-oriented employees, and the treatment of the rewards level clearly showed that workers cannot be considered to have a "natural" predisposition toward safety consciousness; rather, this is socially constructed. In fact, it is quite possible, within this theoretical framework, that an increase in the autonomy available at the command level to workers holding a favorable orientation to productivity, instead of translating into autocommand and accident reduction, may be associated with a rise in accidents. What workers do have, however, and this distinguishes them sharply from management, is intimate contact with most aspects of the workplace that are likely to produce *their* accidents. It is this fact that creates their special awareness and perception of safety issues. Whether and how this translates into safety is a question for sociological analysis. Autocommand can thus be seen as one accident-reducing strategy.

Conclusion and General Hypotheses

The previous discussion leads to the following hypotheses: the greater the weight of the command level in managing the worker's relationships to the dangers of a task, the greater the proportion of accidents produced at this level. The lesser the weight of the command level in managing these relationships, the lesser the proportion of accidents produced at this level.

The Organizational Level

Employers seek to manage work by controlling the division of labor and its coordination. This control is exercised through the domination of knowledge about work, task design, and the coordination of knowledge about tasks. Industrial employers typically engage in strategies to reduce the intellectual content of manual work; thus, job design is separated from execution and working conditions are invested in so as to transform the division of labor, thereby increasing productivity.

The classic image of the organizational level's evolution begins with

skilled workers in craft tasks controlling the intellectual content of their own jobs. In a second phase, with the arrival of semimechanized plants and subsequently of Taylorist and Fordist design and coordination principles, a sharp reduction in all aspects of such control occurred. In a third phase, automatic and continuous process industries are associated with a recomposition of manual and intellectual components of work: operators supervise and adjust the plant's operation and, without working directly with the product, ensure that production takes place.[121]

The sociology of work has invested a great deal of effort in attempting to understand this development and its ramifications. Its historical origins have been related to "the politics of production" and "the politics of consumption." In the latter, the emergence of mass markets has been seen as stimulating development.[122] In the former, employers, aided by engineers, were seen to have progressively designed the skills out of work.[123] Wide agreement exists that the transition from craft to semimechanized industry was associated with the "deskilling" of the craft component of manual work; less agreement exists over what happens to skills in the transformation to continuous process industry.

To make the discussion on the transformation of work relevant to the analysis of errors and, in this particular case, industrial accidents, it is necessary to consider a number of conceptual points. First, all firms, whether in craft or continuous process stages of production, design work so that it is subdivided into tasks. These tasks are performed individually or in teams and each worker has a job to perform that may include just one or extend to many tasks. In industrial firms task design and coordination are the formal responsibility of employers and delegated to their agents. Second, the external resources that employers seek to capture in order to transform them into task structure and coordination, that is, into work, are subject to numerous constraints. Important constraints are the availability and cost of resources, whether human or material, and decisions related to these depend on the mixes of and prices obtained for the firm's output. Certain industries draw on similar resources and sell their output in similar markets. Specific enduring and widespread general patterns of task structure and coordination found in certain sectors by sociologists are frequently explained by reference to considerations such as these.[124] Third, whatever the industry, employers build the foundations of organizational level social relations according to a common method: they invest in a work process and the means of coordinating it; allocate people to tasks, whether manual or intellectual; and do so in accordance with perceptions as to how their firm's objectives can be best met. Recruits in a firm confront a job com-

posed of one or many tasks; each task has a narrow or a broad content, and this leads to different jobs requiring greater or lesser skill from workers. The other side of the coin is that different employer decisions on the organization of work lead to important variations in functional requirements for job preparation and coordination; because of this, managerial roles differ widely.

Three social relations are formed at this level: underqualification, routine, and disorganization.

Underqualification

Workers confront a job with either adequate or inadequate skill levels to perform it effectively; where skills are lacking, their relationship to work is said to be managed by underqualification. To reduce underqualification employers may initiate training programs or, in order to reduce the need for these, restructure the division of labor, rendering tasks less complex or reducing the number of tasks in a job. This simplification of work is a key focus of investment in industry, and may be referred to by its critics as "work degradation"; its advocates call it "rationalization." Workers can combat managerial control of work through this relation by resorting to strategies designed to increase their knowledge of the job and the workplace: informal self-training or job rotation constitute examples.

Advantages and Disadvantages. Management of work through underqualification can be envisaged as having a variety of advantages for employers. Some underqualification is normal in organizations, and on-the-job training is used to transform underqualified personnel into qualified personnel. However, much underqualification directly serves employer interests. At the Children's Employment Commission, people with less qualifications than necessary were employed in certain jobs in order to lower employer wage bills. In cases of labor shortage posts may be filled with inadequately trained staff to ensure continued performance; when rapid technological change occurs, such a process may become the norm simply to guarantee the organization's functioning. Equipment breakdowns and emergencies always pose difficulties for management; delays occasioned in awaiting the arrival of appropriate specialists can be eliminated if personnel who are immediately available set out to solve the problems. Knowledge pertaining to task problems (e.g., the toxicity of certain chemicals) might be hidden from employees for fear that it serve as a basis from which they might organize to in-

crease their power or to refuse task execution. For motives such as these, underqualification is routinely used by management to guarantee work performance.

Organizational members might be able to earn salaries higher than those appropriate to their training by accepting work for which they are underqualified. Clandestine repairs to machinery may result in a quick return to production and thus the restoration of piece payments. Workers may "cover" for colleagues, help each other with repairs, and thereby create control over the distribution and timing of task performance, which may entail a certain rise in underqualification.

For both parties, disadvantages emerge. For employers, poor quality task execution, workplace disorganization, and a loss of control over workplace coordination constitute obvious examples. Properly trained workers may lose the pride that they traditionally derived from their qualifications; reductions in their abilities to earn increased wages may be a consequence of the generalized placement of underqualified personnel. Beyond executing their tasks poorly, some of the underqualified suffer stress and anxiety about their own capacities. A lack of confidence as to the capabilities of one's colleagues may add to the errors produced through underqualification. All these factors render error-free work performance a problematic affair.

Routine

Routine work is the result of job simplification. Subject to this mode of managing their work, adequately trained workers repeat tasks of a fixed content and treat these as nonvariable.

Advantages and Disadvantages. Georges Friedmann, writing with great clarity in the early 1960s, summarized some of the characteristics of this relation and its advantages for employers.

> The standardization of production, exclusively concentrated in one type of machine permits a highly developed rationalization, each piece passing through a cycle of semi-automatic machine tools where all is "given" in advance, tightness, regulation, angle of the piece on the tool, etc. without any error (but also without any initiative) being possible on the part of the operators . . . [their skill] is composed of an habituation to simple, repeated tasks, and to a sort of automatism.[125]

Work becomes predictable, the workforce requires few qualifications, and the workplace can be clearly and simply coordinated.

Workers may perceive a variety of advantages of management through routine: responsibilities are narrowly defined, performance re-

quirements are predictable, little attention to the job might be demanded, and for those with few skills, routine tasks might provide the only work available.

One set of disadvantages of this relation for employers relates to the problems that a heavy reliance on routine work entails if the organization is required to adapt to change. But it is the difficulties within the workplace that hold our attention.

In its various forms (Baldamus has conceptualized four),[126] routine work may produce hurdles of different types. The absence of the necessary minimum variety that some forms of routine entail may provoke a sort of premature tiredness, boredom, and inattention and may lead to negative reactions such as illness, sabotage, and labor turnover. In addition, whenever variability or small difficulties unexpectedly emerge on the job, organizational members may be incapable of dealing with them. In such a manner, the reliance on routine to manage work can become associated with error production.

Employers adopt two strategies to reduce or avoid these difficulties. One seeks to reduce the negative effects of routine without changing task structure: walls may be painted, Muzak played, attempts made to recruit staff judged "adaptable" to such tasks, and rewards level strategies to restore some interest to the job adopted. The other strategy sees employers changing task structure: enlarging the scope of tasks or engaging in job enrichment.

Employees may seek to reduce the relation's weight through informal job rotation or through strategies to reintroduce interest in work by building informal systems of symbolic rewards.

Disorganization

Tasks, whether routinized, performed by the underqualified, or to all intents and purposes free from either corresponding social relation, must have their interrelationships coordinated. When knowledge pertaining to the output of one task is not effectively transmitted to those who come into contact with this output, it can be said that work is managed through the social relation of disorganization.

Disorganization manifests itself in a variety of ways. A machine may break down because its operator's task is formally defined as production and not maintenance and the maintenance staff had not detected its imminent failure. Workers may take shortcuts which unbeknown to them render items inadequate for further processing; however, this may be discovered only when others' contacts with these items reveal the inadequacy. One workgroup may be positioned above

another on a construction site, and a mistake by a member of the former may not be communicated to the latter in time to avoid complications. Piece payment systems are frequently structured so that a drop in wages occurs if machines break down. Workers, as has already been discussed, may informally resort to repairing their own machines in order to avoid pay losses. However, if workers, for whatever motive, lack the necessary competence to effect such repairs (underqualification), difficulties for task coordination multiply (disorganization). This occurs because potential errors are introduced into the system, which have little to do with expected errors.

Process industries, where operators no longer deal directly with the product but monitor its fabrication and where production systems are tightly interlinked, frequently pose major challenges for coordination. Nuclear power or petrochemicals are sectors where this occurs and frequently production rhythms are planned only to permit sufficient time to check expected errors. Where process design is complex and processes interlinked, any unanticipated errors can disturb the next interrelated element. Under such circumstances disorganization can become so pervasive and multifaceted that no procedures are available for the ready restoration of coordination. In extreme cases, where this relation assumes its full weight, the whole workplace may appear to be managed through the relation of disorganization.

Advantages and Disadvantages. It is only in ideal cases such as workplaces with highly routinized simple tasks, or with extremely well-qualified staff working at isolated tasks that the total absence of this relation can be envisaged. In complex organizations at least some management of relationships to work through disorganization may be taken as a precondition for performance.

Complex organizations, as seen throughout this chapter, function in ways that do not correspond to the models of their rational designers. Thus to submit unexpected elements to rational control management may seek to ensure coordination by resorting to a number of specialized methods or mechanisms: production planning departments, critical path methods, routine maintenance programs, and so on. Through such strategies work can be conceived of so that staff and machinery are isolated from the negative consequences of unexpected events. Mechanisms to detect and buffer the impact of unforeseen events can be built, and in this way staff is permitted time to react; when this occurs new skills and qualifications are required as tasks grow to integrate the management of unexpected events. Employers may decide to run processes even when adequate coordination capabilities are not available; such lax

coordination may permit resources to be economized. In such cases, disorganization can be perceived of as a managerial strategy that has the advantage of guaranteeing production, even though it may entail some disadvantages.

Disorganization entails a variety of consequences and these are distributed unevenly. Profits and losses produced by disorganization enter into the accounts of firms, and economically rational competitive firms are capable of tolerating all sources of disorganization that do not result in important financial losses. In this way many employers do not perceive that it is unwise to manage work through disorganization.

The disadvantages of disorganization for organizational members are of a different order from those for employers, and frequently lead to psychological strains, threaten physical integrity, and provoke conflict.

In order to counteract disorganization, staff may informally enlarge jobs, adapt poorly designed pieces, develop informal feedback mechanisms, and, through the command level, pressure to ensure that coordination takes place. Thus, disorganization may produce the space in which staff, even those whose work is managed by routine, develop their own skills, which constitute a part of what are sometimes called "plant specific skills." Through such skills they may increase their power within the workplace and use their knowledge as a basis for developing job control in other areas.

The Organizational Level and Accidents

Difficulties produced by social relations of routine, underqualification, and disorganization include industrial accidents. My New Zealand construction site research indicated, and further research in the five French construction sites provided confirmation of the notion, that the majority of accidents are produced at this level in advanced industrial societies. Let us now turn to an examination of accident production.

Underqualification and Accidents

Underqualification is discussed in the literature under various names, the most common of which is "inexperience."[127] The term "experience" is, however, only a rough approximation to the term "qualification." This is illuminated by a New Zealand construction accident previously referred to where a scaffolding plank broke underneath two relatively "inexperienced" apprentice carpenters. This accident could not be attributed to underqualification since these apprentices were aware of task dangers. It was produced by authoritarianism. Many acci-

dents that occur with inexperienced workers are produced at the command and rewards levels, rather than through the organizational level relation of underqualification. Keeping the spirit of this observation in mind, let us now turn to an examination of the research.

Accident victims had significantly less experience than did nonvictims who worked at matched tasks, according to Powell and co-workers' research.[128] Salengros showed that miners who transferred jobs had twice as many accidents as those who, by virtue of their stability, were judged more experienced at their tasks.[129] Workers may not always be required to repeat the same narrow range of tasks. Some studies indicate that injuries are more likely to occur whenever infrequently performed tasks are executed. In a department where condensers and transformers were manufactured, Trautes found that 60 percent of accidents occurred outside of the worker's normal activities, in tasks occupying only 5 percent of the worker's time. A Swedish study operationalized underqualification in a different manner, by comparing similar work situations that were both subject to and free from accidents; it showed that accidents were produced at a significantly increased frequency when workers were not at their normal workplaces.[130]

The evidence relating to "inexperience" reveals a number of dimensions to underqualification. Let us now turn to a more specific examination of the social relation.

On one New Zealand and five Parisian construction sites which I researched, underqualification was seen to be produced in diverse manners. In the New Zealand site, a laborer's hand was crushed when a skip filled with concrete turned unexpectedly. His lack of knowledge of the task, one of the dozen or so that made up his job, led him to incorrectly handle the skip. On the French sites, where labor turnover rates were much lower than in New Zealand, those brought onto the job by temporary employment agencies appeared to suffer accidents similar to those of "new recruits" in New Zealand. Interviewees suggested they were subject to high accident rates.[131] Underqualification had less weight among French laborers employed by the main contractor than among their New Zealand counterparts.

To prevent accidents due to underqualification, two basic strategies exist: the alteration of the division of labor and staff training. The literature concentrates on the latter and this shall now be examined.

By definition any study that shows the success of training reveals the previous existence of underqualification. Those studies that demonstrate no such success may be demonstrating that the workforce was

well qualified before training took place or that the training techniques were ineffective. In the former perspective, a Swedish study indicated that tree fellers' accident rates could be no further reduced by training since this had been exploited to its limits.[132] Ellis's literature review revealed skepticism as to the value of training. In contrast, two studies he examined from the United States produced a totally different evaluation: simple programs were claimed to have reduced accidents by around 50 percent both in the chemical and the pulp and paper industries.[133] Quinot and Moyen wrote a methodological essay and concluded that, once all available legal and technical measures have been implemented, training will be the key prevention method remaining, opening the door to "tomorrow's safety."[134]

It is in the gap between required training and work practice that underqualification is produced. To fill this gap, employers resort to a specialist training function or to an even more specialized safety training function. Some interesting experimental studies have been made of the latter. Steel employers in Naples deemed that the acceptance of safety devices constituted a part of the knowledge necessary for correct task performance. To facilitate this, two techniques were used and subsequently compared to see which produced the greater modification in workers' attitudes. Group discussions were found to be more effective than formal lessons.[135] In an experimental study, simulation and teaching machines were employed to train 30 power press operators and were found to be more effective than traditional methods. Studies of this nature support the idea that training has a role in reducing accidents. But "training" can mean much more than classroom work or on-the-job teaching of workers new to tasks. Matters related to job safety may with time fade from workers' consciousness. In such cases, retraining may become necessary. In the steel industry, safety posters were used in an attempt to modify an action judged to be particularly dangerous: that of omitting to hook up slings. Subsequent to their posting the rate of hooking in the best shops rose from 42.2 to 55.7 percent, and in average shops from 37.6 to 45.4 percent.[136]

Neither the social relation behind the "nonhooking" practice that was dominant prior to the poster campaign nor the reasons for the continued postcampaign high rate of nonhooking were investigated. It is not surprising, given the structural basis of such studies, that such important details appear to be missing. Ellis and Hale and Hale have characterized training studies by their general methodological poverty.[137] Few are the studies in which training requirements are investigated prior to making relevant decisions. An exception is that of Cock and

Cloots who developed a questionnaire and a test in order to discover who used poor work methods, and the identified workers were then trained. A 40 percent drop in the number of accidents is seen as an endorsement of the procedure adopted.[138] The opposite strategy was to be found on a New Zealand construction site. Carpenters, my research indicated, had no great need for training, yet they received it. Laborers, in spite of their important needs, were excluded from training programs. The high turnover of laborers compared with the high stability of carpenters had led to management defining laborers' training as a wasteful investment.

A national survey in the United States showed that the majority of evaluations conducted of formal health and safety training cannot determine if it is effective.[139] This is seen as partly due to the poor use of evaluation techniques by company officials. However, there may be a more theoretical reason: evaluators may not have a sufficiently complex understanding of the social mechanisms surrounding training's introduction into the workplace.

Through this discussion of underqualification, the limits of training have been located in two areas: the design of programs and the knowledge that is required in a functional sense to ensure task performance. The hypothesis that emerges therefore is that where training is inappropriate, it does not reduce the weight of underqualification, but where appropriate, it does. Blanket perspectives, and that quoted from Quinot and Moyen is a prime example (see note 134), that place training on a pedestal among prevention techniques lack foundation.

Routine and Accidents

Design principles of mass production industry tend to lead to work being structured as a routine activity. Raymond discusses voluntary and involuntary gestures that produce accidents. Referring to a specific type of accident that he analyzes as being a consequence of a noncontrolled yet conditioned reflex, he states: a person "is transformed into a robot; he is the slave of machine and materials and submitted to all their caprices." The conditioned reflex permits normal routine work to be carried out efficiently. Should a new situation suddenly emerge, however, the mind may be perfectly capable of making sense of it, but the former reflexive action continues. An accident, produced by the social relation of routine work, may follow in consequence. Raymond elaborates this idea with detailed reference to woodworking on a lathe. Rapidly repeating the same task over and over again, the operator takes a piece of

knotted wood (a rare case) but, although "aware" of the danger of it being expelled from the machine and producing injury, feeds it into the machine because work has become dominated by the conditioned reflex.[140]

The existence of this reflex in problematic situations has been called "overfamiliarity" by some psychologists. Hale used this concept "to explain why warning signs of impending errors were ignored." He related this to the idea of expectancy, where "the operator looks only for the cues he expected to see and failing to scan the situation for contrary indicators."[141] Laner found only one category of accidents that increased during his four-year steelworks study: those involving the handling of everyday tools. This he explained by referring to overfamiliarity which was seen as producing failures in attention.[142]

Routine may lead workers to act in such a way as to "deroutinize" their task or to reinject interest into it. "The monotony of repetitive tasks, is it not lived as true alienation?" asks Caillard. "To have been unable to escape such work is often considered a failure; an attempt is sometimes made to compensate through non-conformist behavior, this becoming a generator of accidents."[143]

The negative consequences of routine are recognized by certain social actors who engage in efforts to limit it. An International Labour Organisation compendium entitled, *Occupational Safety and Health in the Performance of Monotonous Work,* based on a conference in the Soviet Union, highlights various strategies for the control of routine's negative consequences. For some, monotony can be prevented through plant design, but for others it is necessary to consider adapting staff to such work or piping music into the factory.[144] Such strategies have also been discussed by Friedmann in the capitalist world.[145]

However, attempts to reduce the weight of a social relation may produce perverse effects. Smith's experimental research showed certain links between the playing of music at work and increased accidents: marches had less negative influences than waltzes; on day shift music was more dangerous than on other shifts; and music had particularly negative consequences during the first week's playing.[146] Important though Smith's findings are by themselves, future research of this type should, from the viewpoint expressed here, attempt to construct explanations of such increases in terms of a theory that is sociologically grounded. In this way both the limits of such theorization and its relevance will come to be more clearly specified. Equally, the attempt to redesign work, by changing the division of labor and thereby reducing the weight of routine may result in new accidents, especially to workers

who become underqualified as a result of their new job structure. This is the central thesis of an article with the revealing title, "Job Enrichment: Cause of Increased Accidents?"[147]

Disorganization and Accidents

When workers lack knowledge about factors external to their job and when this lack of knowledge results in their inability to act to avoid danger, the social relation of disorganization produces accidents. In modern industry, employers take formal responsibility for task coordination. A part of this responsibility is exercised through the transmission of knowledge about interrelated tasks to workers and through the separation and control of tasks with potentially problematic interlinkages. Management produces disorganization when it withholds vital information (particularly to defend its interests, as when trade secrets or costs are involved), when workers are brought into contact with transformed social relations (whether these are "natural" or made by humans is inconsequential) about which adequate knowledge is not available, and by its own internal lack of communication and coordination.[148]

Wide variations in managerial coordination efforts aimed at guaranteeing safety can be found between firms and industries. In a continuous operation plant, foremen were found to spend 1.5 percent, and in a job-lot plant, 0.2 percent of their time on safety matters.[149] In U.S. coal mines, this proportion has been seen to go as high as 30 percent.[150]

When supervisors work on safety-related activities, they normally do more than simply coordinate work. A supervisor engaged in general work coordination will inevitably be performing some tasks that are linked to industrial safety. The designation of a certain group of activities as "safety activities" is a social act produced through a complex interplay of factors. These include legal demands, trade union pressure, and functional exigencies emanating from the division of labor. Where political forces, for example, emphasize safety activities, a firm may respond with window dressing by placing some general personnel and supervisory functions under a specialist safety classification. In the absence of such pressures, safety activity may be integrated into general functions. It is always important to distinguish between "nominal" and "real" safety activity, for in so doing it becomes easier to understand an apparent paradox: some firms that appear safety oriented display high accident rates and, conversely, comparable firms with few nominal safety-related procedures would appear, through their low accidents rates, to have many "real" procedures.

Firms with visibly dangerous premises were observed by Jones to have low accident rates in some cases. On the other hand, some that were seen to comply with conventional safety measures experienced high rates.[151] From the workers' side, two explanatory hypotheses can be formulated. First, workgroup organization, knowledge, autonomy, and orientations combine in such a way that visibly dangerous elements of the workplace are acted on in safety. Disorganization constitutes an expected element in the workplace, and workers display collective vigilance; because of this, they show a capacity to avoid dangers. Second, when a workplace is visibly safe and well organized, workers may have little inducement to acquire knowledge of potential sources of infrequent disorganization. In such a case, workers subject to disorganization are more likely to suffer accidents than their vigilant counterparts.

My construction site research confirmed the plausibility of such complementary hypotheses. In the New Zealand site, laborers, as a consequence of the uncertainty surrounding elements exterior to their multiple tasks, were always on the lookout for dangers, whereas carpenters, working at one major task and in a far more stable environment, were not. In one incident a carpenter stepped onto his work platform, which had always been installed in the same relative position since construction had begun; however, on this occasion some of its planks had been removed by a subcontractor. He was very lucky not to have fallen to his death. A laborer, always subject to disorganization and on the watch for the unexpected, would never have stepped onto a platform without looking at it first. The reverse was the case for carpenters, and their work platforms were treated as a fixed element in their workplace. Compare this incident with the analysis presented to the British Building Accidents Committee in 1907:

> . . . scaffolding is oftentimes removed from its place, and in consequence proves a source of danger to those employed on the building, the workmen having been accustomed to planks being there, depend on them still, but the planks or plank having been removed, leaves an opening which many times proves a trap to the workman and results in an accident.[152]

A more obvious and direct link between disorganization and accidents is discussed in the literature: an industrial robot that breaks down and injures a worker[153]; a scaffold that collapses because it was improperly erected by pieceworking subcontractors[154]; or, as on a French site, a worker being injured when the rusting wires holding a ladder broke because it was not his task to check the wires. Such events all involve the unavailability of adequate knowledge about the state of machinery or materials. Such accidents can be produced in any industry, whether craft or continuous process. The type of knowledge to be trans-

mitted can be as simple as that omitted in the French construction site or as complex as that needed to control nuclear reactor failures.

Disorganization frequently introduces new problems into the productive process. In breakdown and similar situations, workers are often observed as acting outside of their areas of expertise to guarantee production. They change their task to do so and from this point on their work may become managed by underqualification. In French iron mines, Defoin found accident rates on repair tasks to be four times as high as on normal work.[155] Such a statistic probably mixes disorganization and underqualification.

But why do workers execute tasks that lie outside their normal work demands? A substantial segment of the safety literature depicts this as occurring because they do not care about their own safety. Nichols and Armstrong oppose such an explanation and see these actions as being a product of a workforce orientation whereby they share values with employers to keep the job going.[156] Such orientations, whether related to the rewards or command levels, are frequently discussed outside of a sociology of accidents. Indeed, Roethlisberger and Dickson found workers referring to their peers who did not act in terms of a production orientation as "chiselers."[157]

Employers are faced with a large variety of potential sources of disorganization. If these are judged to prevent the realization of objectives, controls may be implemented. Such controls may be as varied as the forms of disorganization they are designed to combat. Workers may use informal or even prohibited channels to reduce exposure to disorganization and the risks that it carries.

Interlude: The Changing Face of Disorganization—The Case of Post-industrial Work. As industrial design integrates principles that augment production complexity and as tasks become more highly automated and interlinked, a growing potential to design disorganization into systems emerges. The nature of disorganization is different from that found in traditional industry. In a disorganized system, actors appear less able to understand and operate through use of their cognitive skills. Safety devices are found to frequently induce incomprehension and error rather than prevent them. Workers' capacities to develop an understanding of the workplace, to develop a notion of truth, are undermined, perhaps irredeemably so.

Three Mile Island appears to be watershed, and in subsequent discussions on the future of work this "new disorganization" has become an important issue. Disorganization has now become, more so than any other accident- or error-producing social relation identified in this chap-

ter, the focus of systematic investigation. Indeed, its emergence as an issue has resulted in the opening up of dialogues between sociology and other disciplines. Perrow; Wisner, Daniellou, and Dejours; Weick; Leplat; and Hirschorn[158] are among the scholars making contributions to our understanding of this emergent phenomenon.

Organizational Level Strategies for Accident Reduction

Organizational level safety management is the employers' strategy to reduce accidents at this level. We have briefly seen that different management techniques from training to coordination attempt to do this.

Rules and procedures have two components: one relates, as we have seen, to the command and rewards levels, and the other to its capacity to build functional communications between subsystems and tasks in the organization. Combining these, management seeks to ensure the predictability of work and worker action. Once action is predictable, coordination between tasks can be reduced to strictly formal and routine procedures. But rules can be disobeyed and procedures can be broken down, even when they are backed by the threatened use of command power. Faced with their inability to dominate the human element, some employers turn to engineered safety; through this they seek to make procedures automatic and free of any possibility for human discretion or error. The reduction of safety activities to the physical protection of machinery and materials, especially through guarding mechanisms, reflects this view.

Guarding and other forms of physical protection enter the workplace as a result of employer investment decisions and worker acceptance of such decisions. A "machine guard" can range from a dog leash adapted to prevent workers from reaching their hands into the driving cogs of their machines to electric eyes and highly sophisticated computer-controlled fail-safe systems. Whether in construction or in petrochemical industries, guarding can help shield workers from the effects of failures and dangers.

Safety devices, however, as we saw with the Davy lamp, are inserted into the workplace in complex ways. Kuyer's study of safety glove use provides a modest contemporary illustration. Older workers wore gloves significantly less frequently than their younger counterparts and suffered fewer hand accidents.[159] Hale and Hale's literature review revealed that only a small number of research papers reported the success of investments in machine guarding and safety design modifications.[160] A more recent Finnish survey showed 27 percent of loggers claimed that safety equipment had prevented potential harm in the previous year.[161]

Guarding is a product of investment decision that may be stimulated by external or internal forces. In competitive sector firms, their capacity to produce profits, as Bird and Germain have argued,[162] appears to be an important consideration. In most industrialized nations, legal demands, when they seek to equate industrial safety with universal adherence to certain standards, remove profit considerations from some decisions. However, a British Chief Inspector of Factories estimated the limits of such an approach when he depicted guarding as capable of achieving a maximum of a 10 percent reduction in accidents.[163]

In a futuristic vein, Salim proposed that robots may be capable of guaranteeing even higher levels of safety than industry has thus far achieved.[164] Other writers look beyond mechanical means and toward new management techniques as a means of guaranteeing a state as close to total safety as possible. In this way integrated hazard control systems, probabilistic risk analysis, fault tree analysis, and system safety enter the workplace. Each seeks, in its extreme forms, to invest management with complete control over the organizational level. Ideally, the effects of such techniques and strategies should be interpreted through the modifications they entail for the management of work—for social relations.

However, a competing idea of the organizational level exists and sees safety being provided through the development of "human-oriented techniques." It goes beyond command level safety management, which involves discipline, rules, procedures, and participative bureaucratic strategies, and looks toward training, job rotation, and participative organizational processes. This last approach, particularly in the form of safety committees, has experienced considerable growth in recent years. Such committees, besides having the command level function identified earlier, permit worker knowledge (which generates more accurate evaluations of job risks than does management knowledge[165]), particularly that relating to disorganization, to be transmitted. By obtaining such information, management can become more effective, particularly in its management and coordination of the organizational level. It is worth noting that, in spite their considerable potential, the success of these committees has not been clearly demonstrated in the literature.[166] A hypothesis is that these committees produce perverse effects that articulate into work relations, in particular at the command level, in a way that increases accidents or accident reporting. Such an increase might well offset any reduction in (say) disorganization attributable to the action of these committees. It is clear that a better theoretical understanding of the mechanisms of their insertion into the workplace, backed up by case study research, is necessary if committees are to serve

as an effective tool not only of organizational level safety management, but of accident prevention.

It has been suggested that one fruitful activity is "participative design," whereby employees, as a result of knowledge acquired on the job, identify and help formulate solutions to problems.[167] However, such activity can effectively transform the relationship between design and execution only if appropriate investment decisions are made. For reasons that relate essentially to the preservation of managerial interests, few workplaces appear to be open to such a model of decision making.

In this examination, safety management at the organizational level has been seen to be associated with two strategies: new investments and a reordering of knowledge flow between management and workers, whether through transforming the division of labor or transforming the workers' knowledge within it. Its action may decrease accidents at this or at other levels.

Auto-organization is the name given to workers' attempts to produce safety through controlling the organizational level. It includes work deroutinization, informal training, and informal coordination of knowledge about tasks. Certain worker initiatives of this type may come to be formally accepted by management. Auto-organization can be carried out overtly, or where employers are perceived to hinder it, covertly.

Workers, from the early days of British industrial coal mining to recent surveys, have consistently shown themselves to have an acute perception of the dangers and risks of their jobs. It can be hypothesized that, free from direct domination by social relations at other levels, free from routine and having control of all knowledge necessary for task performance and coordination, workers would not be subject to organizational level accidents. Such a hypothesis relates to a theoretical "ideal type" which, at an empirical level, would be most closely approached in some traditional forms of craft work.

When workers are unable to achieve the degree of auto-organization they judge necessary, they may resort to the use of command power. Through negotiations or strikes they can demand changes in the functioning of the organizational level: new patterns of investment in systems, equipment, and human resources; new communications flows; new task structures; or a new division of labor.

Conclusion and General Hypotheses

The greater the weight of the organizational level in managing workers' relationships to the dangers of their tasks, the more important

will be the production of accidents at this level. A reduction in this weight will reduce the proportion of accidents produced at this level.

The Individual Member Level

There exists another level of reality, one that is nonsocial. It is the autonomy that individuals retain even though, as members of organizations, they are engulfed by work relations. It is that part of the worker that is neither organized, commanded, nor rewarded.

Three dimensions of the individual member that exhibit autonomy from systems of social relations shall be examined: the psychological, the cognitive, and the physiological. In line with this autonomy the individual member may behave in ways defined either as desirable or as undesirable by employers. Try as they may, employers neither govern this level nor control the consequences of its operation. Staff selection, discipline, rewards, and the routinization of work are among management techniques designed to constrain the role of behavior at this level.

The Individual Member Level and Accidents

A general hypothesis can be formulated about the functioning of the individual member level. Where employers perceive, independent of considerations from other levels, the necessity to limit individual action, they will reduce the "space" for the operation of this level to a minimum. The film, *The Right Stuff,* in its depiction of the rigorous physiological, cognitive, and psychological tests undergone by would-be NASA astronauts, and in its portrayal of the efforts of system designers to reduce to a minimum the possibilities for "turbulence" due to individual member actions, is an extreme case that supports this hypothesis. In a similarly motivated effort, the United States Navy's nuclear submarine program subjects sailors to extremely strict discipline.[168]

When we move toward the examination of activities in competitive sectors of industry the actual role of this level comes into perspective.

Cognitive psychology attempts to locate the origins of errors in the cognitive deficiencies of individuals. In this manner, color-blind workers, for example, could be expected to have accidents if their job requires color vision. Surprisingly, some research evidence does not show that this expected link exists, and this is taken to suggest that workers develop mechanisms to compensate for their deficiency.[169] However, it may be difficult to develop adequate mechanisms in all cases of deficient cognition. People with ordinary visual deficiencies, for example, were

shown in Tiffin and McCormick's work to be slightly more susceptible to accidents than those with good vision.[170] Sensory-motor skills[171] and hearing[172] are other cognitive factors studied in attempts to calculate their weight in accident causation. The difficulties encountered in attempting to establish a relation between vision and accidents are but one small indication of the complexities of this field.

Worker qualifications necessary for the operation of certain computer-related tasks and control systems increasingly have a cognitive component. Reflecting this, some employers in recent years have backed efforts to systematically codify work and select staff on the basis of particular cognitive skills, and to foster the development of such skills through training. As such practices become more important, the role of cognitive deficiencies in the individual member level declines because cognitive qualities, increasingly defined as a component of qualification, become integrated into the organizational level. The changing status of cognition has not passed without considerable attention from psychology, medicine, and ergonomics in their attempts to understand the relationships between machine systems, human cognition, and errors.[173]

Physiological factors, such as strength, blood pressure,[174] resistance to heat,[175] or illness,[176] are further individual member factors that can be associated with accidents, their production and prevention.

Psychological factors are seen in an important part of the specialist literature as responsible for the overwhelming majority of accidents. Aggression, neuroticism, or self-punishment are among specific causes identified by Hale and Hale.[177] General labels such as carelessness, accident-proneness, or simply unsafe acts are used with greater frequency. Beyond purely psychological causes there lie a series of physiological alterations that have alleged psychological origins: alcoholism and drug use are commonly referred to. Metz and Lederman showed in 1960 that those with a blood alcohol level above 0.05 gram/liter had 11 percent more accidents than those with a count below this level.[178] Although further French studies have confirmed such a result, a British study did not.[179]

Research examining the role of other psychological variables in accident production has proven remarkably inconclusive. Hale and Hale called "psychological" factors "personality variables." Their literature review examines some 350 studies and concludes that "industrial safety has not yet reached the stage where personality variables have shown themselves as important"; they list factors that are probably capable of providing better explanations: ". . . machine design, environmental conditions and training."[180]

Research of the individual member level typically omits two impor-

tant lines of reflection: first, that employers frequently do not use their command power to limit known accident-producing behavior, and second, that employers may dangerously manipulate the individual member level to ensure performance. A simple question illustrates the first point: would French nuclear power station employers tolerate the same levels of staff drinking as their counterparts in the construction industry do? The negative answer indicates that managerial control over this level must be viewed as a somewhat discretionary affair. A case from one of my Parisian construction studies illustrates the second point: a laborer, protected by a safety harness, fell while working on the exterior of a building. Shaken, he was unwilling to return to the task. His workmate told of the foreman's strategy to wash away such resistance: the victim was invited for a drink. "He took a small drink, me too, then . . . let's go! All the same, it [the incident] was a small shock."

Some General Considerations

MacKeith analyzed statistics collected by a United States insurance company and attributed 80 percent of accidents "to personality defects in the form of accident proneness."[181] As we saw in Chapter 2, Heinrich, in seeming defiance of his own theories of prevention, attributed some 88 percent of accidents primarily to "unsafe acts".[182] The problem with such generalized notions is that from the moment the human factor is considered to be the cause of accidents, everything the worker does and omits to do can be blamed. In this way a definition can be easily arrived at in which nearly all accidents are attributed to the worker.

The psychological approach to accident prevention was discussed in Chapter 2, and now, like engineering, legal measures, medicine, and ergonomics, the challenge is to interpret it within a framework that is sociological. The sociological theory as formulated in no way denies the importance of individual member factors in accident production. It gives priority to the examination of the role of social relations. In this way, accidents join other workplace phenomena in being subjected to sociological analysis.

What then is the importance of the individual member level in accident production? Individual member characteristics such as age, gender, strength, or hunger, infiltrate social relations and thus alter the way in which work is managed and accidents produced. To eliminate such accidents two paths are open to employers: the appropriate replacement of those with "undesirable characteristics" or the transformation of work relations.

This level can also be associated with accident production when the

worker acts individually (without collective referents) against domination by work relations: the pieceworker sabotages in order to reduce production rates; life rendered intolerable by authoritarianism, a worker perpetrates an injury to escape work and receive accident pay; the lone job deroutinizer introduces novelty. Alternatively, such workers may quit the workplace: the injured worker may, financial circumstances permitting, opt to receive compensation instead of returning to the job.[183] Such discussion inevitably raises the twin specters of self-injury and malingering. Powell and colleagues, in their examination of more than 2,300 accidents, closely investigated alleged cases of malingering and attached no significance to such allegations.[184] This of course does not mean that the practice does not exist in workplaces subject to other social relations or that one can conclude that self-injury does not occur[185]; what is necessary is for such behavior to be rendered explicable in theoretical terms.

Conclusion and General Hypothesis

A sociological theory of work accidents leads to the hypothesis that examined in isolation from the social relations of work, the proportion of accidents produced at the individual member level should be small.

INTERLINKING LEVELS AND DEVELOPING GENERAL HYPOTHESES

Thus far, particularly in the discussion of social relations, very little attention has been paid to the interlinkages between levels of reality. The series of construction site studies I conducted showed quite clearly that social relations at each of the three levels coexist in the same workplace, and that the dominance of one may be substituted for another depending on employer and worker strategies and reactions.

A complete discussion of the possible interrelationships between levels would turn this chapter into a general theory of work. Such an effort clearly lies outside of the scope of this book. These interrelationships and interlinkages are commonly discussed in theoretical sociology, management literature, and in workplace monographs. I will now analyze two examples to provide the reader with an idea of how linkages between levels can be conceptualized and of how the linkages may affect the production of accidents. The first example is hypothetical and general, the second empirical and specific.

A number of studies examined indicate that the presence of trade

unions in the workplace results in lower accident rates. From such studies it seemed that, except in the case of employer-sponsored ("scab") unions, the presence of unions has the reduction of the weight of the command level as its primary general effect, and especially of authoritarianism. The expectation therefore would be that such presence would be associated with a relative decline in accident rates. However, a reduction in the command level's weight may be linked to an increase in accidents at the organizational level. Union presence is associated in the literature with less labor turnover. This may reduce the weight of underqualification but, should tasks be limited in scope, a decrease in labor turnover may result in increased routine work and a consequent rise in associated accidents. In conclusion, it is theoretically possible for reduction in accidents achieved as a result of worker actions at one level to be associated with their increase at another level.

In the literature, incentive payments and authoritarianism are seen as substituting for one another as managerial strategies.[186] On one French site I researched employers managed work by specifically linking rewards level strategies for a minority of workers and command level strategies for the rest. The lead gang consisted of a small group who were paid to be the pacesetters. The other workers under pain of sanction, were forced to match the pace of the lead gang. In each group accidents were explained as products of the different social relations that managed activities.[187]

General Hypotheses

The reality of most workplaces is that work is managed at more than one level, and that the relationships between levels can be simple at one moment and complex at another. A sociological theory has been formulated and during the course of its elaboration, numerous hypotheses have been either suggested or derived. These are all capable of being tested. The four major and most simply stated hypotheses are:

1. Social relations of work produce industrial accidents.
2. The greater the weight of a level of social relations in the management of workers' relationships to the dangers of their jobs, the greater the proportion of accidents produced at that level.
3. The greater the degree of autocontrol by workers at a level, the lower the proportion of accidents produced at the level the worker action seeks to control.[188]
4. The greater the degree of managerial safety management at a level, the lower the proportion of accidents produced at the level the management action seeks to control.[189]

As a necessary prelude to testing these hypotheses, in Chapter 4 I will discuss a number of considerations relating to methodology and design. Such considerations lead to a decision to conduct case studies in a series of factories where shifts are worked. The method and the study's design, like the sociological theory, break with dominant traditions in industrial accident research.

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126. W. Baldamus. 1961. *Efficiency and Effort,* pp. 61–65. London: Tavistock.
127. Hale and Hale, 1972, pp. 35–36.
128. Powell *et al.*, 1971, p. 14.
129. P. Salengros. n.d. *Recherche dans les Charbonnages Belges. Recherche Communitaire sur la Securite dans les Mines et la Sidérurgie, Rapport 3–2.* Luxembourg: Communauté Européene de Charbon et de l'Acier, cited in Faverge, 1967, p. 76.

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pour l'Amelioration des Conditions du Travail, Lettre d'information, no. 74. Includes case study material that confirms the utility of such a strategy.

168. Perrow, 1984, pp. 337–338.
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183. Faverge, 1967, p. 115, relates a doubling in accident rates when compensation was increased from 50 to 80 percent of salary.
184. Powell *et al.*, 1971, pp. 28–29.
185. B. Veillet-Lavalle. 1989. Des dockeurs accusés de s'automutiler pour toucher une rente. *L'Evénement de jeudi* 9–15 November, pp. 34–36.
186. Yarrow, 1979, p. 183. D. Gartman. 1979. The assembly line and capitalist control at Ford, in Zimbalist (ed.), 1979, p. 199; discusses the use of a seemingly identical strategy at the beginning of the century. Trist *et al.*, 1963: "there were two essential methods by which management could seek to control the cycle: direct coercion and price negotiation. The nature of work in the underground situation is such that a close regimental type of supervision has never been feasible, apart altogether from the resistance it would arouse. Coercive control has only limited usefulness. The method of price negotiation was established as a principal feature of the single place tradition" (p. 64).
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188. This hypothesis is not seriously entertained in mainstream specialist literature. Some of the literature already referred to (e.g., Robinson, 1982; Agence Nationale l'Amélioration des Conditions de Travail, 1983) does, however, suggest that employee cooperation with management can contribute to a reduction in accidents. This hypothesis does not limit itself to such a suggestion.

189. Ellis, 1975, pp. 184–186. In keeping with this hypothesis, the author concludes that the consistency with which "top management" involvement in safety is linked in the literature to reductions in accidents makes the subject worthy of further investigation.

4

Methods and Research Design

In the previous chapter, it was theorized that industrial accidents are produced at three levels of social reality—rewards, command, and organization—and at the nonsocial individual member level. At each social level employers and workers struggle for control and enter into agreement over the management of relationships to work, and as a consequence, goods and services as well as accidents are produced.

Prior to testing hypotheses drawn from the theory, it is necessary to discuss two points: the criteria to be used for hypothesis validation and study design. The first discussion relates to the general question of explanatory criteria in the social sciences, and the second is grounded in both the literature about and prior personal experience in researching accidents.

EXPLANATORY CRITERIA

Causal and Meaning Adequacy: The Criterion for Hypothesis Validation

To test hypotheses derived from any theory it is necessary to develop a criterion for the validity of explanation. The criterion I use is influenced by my interpretation of Alfred Schutz's work on Weberian sociology.[1] For an explanation to be considered valid, it must be both causally and meaningfully adequate.

Causal relationships can be established by the use of observational, statistical, and documentary data. These data are assembled to test the validity of hypotheses under examination. But causal evidence alone is insufficient for an explanation to be considered valid.

The knowledge and orientations of actors form an integral part of their social relations. Thus, understanding of the role of social relations can only be achieved when the subjective meaning states of these actors are considered. In this manner, hypotheses that are supported by causal evidence can only be considered valid when they are congruous with the significations actors give to actions. This requirement for meaning adequacy is fulfilled through reference to actors' meaning states. This reference does *not* imply, however, that an actor's first impressions in a questionnaire or in an interview provide "meaning." Rather, such impressions are to be compared and contrasted, through a research process, with the meanings of other actors and with analyses built up in terms of theory that appear to be causally adequate.

Semistructured interviewing is a technique that permits such a research dynamic. Through it actors modify initially attributed meanings, and researchers reevaluate causal connections made. Through the dynamics of this interaction, explanations that are both causally and meaningfully adequate are constructed. For these reasons, this technique appears to be useful for the minefield that the sociological study of error production in organizations represents. I use the word "minefield" because actors seek to deny responsibility for their actions, blame scapegoats, are burdened with guilt, and become scapegoated themselves.[2] For example, some school dropouts see their actions as proof that they are "no-hopers". A more specific example is that of a male construction worker who refers to his nonwearing of a safety helmet as relevant evidence of his personal carelessness in explaining the cause of an accident in which his foot was crushed. Such explanations are incompatible with sociological theories that construct ideal types which aim to explain the social by the social, to explain error production in terms of social relations and not individual weaknesses. Ideas held by actors that appear inadequate from a causal viewpoint can be contested by the researcher through the interview process, and hypotheses relating to causal connections can be reformulated and meaning states modified through reference to theory.

Such a research dynamic may appear to be isomorphic with what Denzin[3] called triangulation, where the accuracy of evidence gathered by one technique is checked against that gathered by another and explanation emerges from the process of checking and counterchecking. Schutz's notion can encompass that of Denzin; however, the former's overall criterion of explanation is quite different: the subjective meanings of actors and the construction of theoretical ideal types that contain references to both causal and meaning adequacy are accorded a fundamental role in explanation. As Schutz explains it, using ". . . Weber's

terminology, the ideal types constructed by social science, and above all, by interpretive sociology, must possess at the same time both causal adequacy and meaning adequacy."[4]

Difficulties with the Criterion

The use of this criterion for the explanation of error production evokes three important difficulties. Actors' consciousness is fragmented, which has consequences for the development of coherent explanations. This is linked to a second problem: that of differences between the meanings held by hierarchical superior and subordinate actors. These two issues relate in turn to a third: that of the relationship between the knowledge drawn from other causal models (e.g., models derived from the natural sciences) and sociological explanations. Let us now elaborate and examine each of these points.

The Fragmentation of Actors' Consciousness

Schutz's conception of a person's stock of knowledge touches directly on the first problem.

> As a whole, this stock is incoherent, inconsistent and only partially clear. It serves his [the social actor's] aims adequately to the extent that its formulae produce satisfactory results in action and satisfactory important explanations. On the contrary, philosophical and scientific knowledge serves only intellectual interests and is subject to control by rules of coherence and consistency, et cetera.[5]

The worker's consciousness is normally fragmented and disarrayed. A variety of messages about safety, fault, and regulations add to the disarrangement built by changing tasks and workmates, and to different perceptions built up outside the workplace. Such fragmentation was clearly illustrated in my New Zealand construction site study: different patterns of thinking about the task and its dangers appeared to be closely related to the group's role in the division of labor. Due to their different work roles each group experienced accidents differently, and in analyzing accidents produced under normal working conditions, no one group analyzed them in a similar manner. When working under pressure was discussed, however, a common perception of dangers developed.[6] Because sociologists stand outside of such groups, they can reassemble the diversity and fragmentation shown in interviews into a unity. This unity is built not only through the pooling of opinions of a representative sample of staff but also, as in anthropological literature, through recourse to "key informants." These, because of their experi-

ences or perception, are better able to assist the comprehension of the workplace than the average interviewee. Through such a research process I was able, in series of construction site case studies, to reach causal explanations of empirical accident production that were both sociological and frequently went beyond "commonsense notions" to be seen as meaningful by workers. The previous success of the approach suggests its further utility in testing the theory.

The acquisition of meaning data can result in the invalidation of the researcher's initial causal hypotheses. A confrontation with causal data can force actors to alter their subjective meaning states. Where conflict endures between causal and meaning data, a satisfactory explanation is not considered to have been developed.

Treating Meaning Data from Diverse Actors

The crucial data for establishing meaning adequacy are those drawn from members of social categories exposed to the consequences of error. Where the members are totally passive (as in the surviving passengers of an air disaster) data are drawn from those actors directly involved in the production of the error (e.g., air traffic controllers, surviving crew). What does a researcher do about meaning data gathered from social categories that are not involved to such a degree and that conflict with the meanings that these actors attribute? In the area of accidents we see that supervisory staff, detached from the realities of manual work and responsible for overseeing it, is widely perceived to explain accidents in terms of individual fault,[7] and in so doing they blame a factor which they do not control.

Superior actors—be they airline managers, surgeons, school administrators, or foremen—are reluctant to attribute responsibility for the production of error to actors at their own hierarchical level; they are far less reluctant to attribute this responsibility to their subordinates—pilots, nurses, pupils, and workers. Such attribution frequently takes the form of scapegoating; it rarely is made in terms that are compatible with the constructions of a sociological theory of error. Thus, in construction site studies, I found that supervisory staff frequently promoted and defended explanations that were causally invalid. Their perception was a product of meaning systems compatible with their interests, culture, and information as expressed through their roles as supervisors and nonmanual workers. When faced with sociological explanations that conflicted with their meaning states, some managers revised their original explanations of accident causes; however, such revision did not necessarily imply an adoption of a sociological perspective. I confronted

one site manager with the hypothesis that the structure of the division of labor (viewed in terms of the theory as specific organizational level social relations) was the cause of site accidents. He fell back from his original individualistic explanations and said, "I look at the economics of the system, that's what's important for me . . . to be honest. When we started we needed five weeks to complete a floor; now, I don't need more than three weeks . . . this system is faster because the job's repeated." In another interview a French manager transferred the blame he normally placed on workers onto himself. He did this after I had remarked: "You said the other day that accidents are the worker's fault. Now you tell me [in response to questions relating to empirical accidents] that accidents happen because of supervisors' threats, because workers don't understand each other due to language difficulties, because people haven't the qualifications necessary to perform their job. . . .The workers tell me that accidents are frequently caused because 'the bosses don't give a damn.' What do you think?" He replied, "We are often guilty, and it hurts me when I'm guilty . . . hurts me a lot—it hurts me each time there's an accident, even if I'm not guilty."

It is worth reemphasizing what was said in opening this discussion: from the viewpoint of the theory developed, those directly involved in the execution of work, those who interact with workplace problems and do so in function of their capacities, orientations, autonomy, and knowledge are capable of conferring or denying the meaning adequacy of the causal explanations developed.

Relationships between Sociological and Other Disciplinary Approaches

Nonsociological approaches, such as medicine, psychology, ergonomics, and engineering, rarely make reference to the meanings social actors attribute to their actions. What role, one might ask, does the sociological criterion of explanation attribute to the explanations developed by these disciplines? Schutz's analysis, once again, guides a reply: ". . . it is immaterial whether the events in question add up to a human action or whether they are nothing more than a series of happenings in the world of nature." He adds, "As a matter of fact, the concept of causal adequacy was first advanced by the physiologist Joannes von Kires."[8] Knowledge produced by such disciplines must, where it establishes valid causal associations, be incorporated into the theoretical frameworks built up by a sociological approach. Translation between disciplines is, for epistemological reasons, an enormously complex affair; because of this only a small part of one discipline's validated knowledge

may be able to be reworked and incorporated into another's perspectives. Once incorporated, such knowledge can help actors better understand existing causal relationships, but it cannot produce valid explanations in isolation from meaning contexts. On the other hand, actors' explanations are considered inadequate if they do not correspond to criteria of causal adequacy.

In other words, the analysis of the production of error must explain the genesis of errors in terms of social relations. The valid teachings from other disciplines must be incorporated, where possible, into a theory of social relations and through this made testable within a framework built up according to sociological criteria. Disciplinary practices have normally demanded the reverse: that sociology subordinate its conceptualizations to theirs. Viewed from a sociological perspective an engineer's idea that a certain type of guarding mechanism prevents a particular type of accident must be reinterpreted theoretically. For example, such an intervention might be perceived of as organizational-level safety management designed to reduce the weight, not of organizational-level relations, but of financial incentives in accident production. This is one hypothesized effect of guarding; of course such a hypothesis can be considered valid only should it prove to be both causally and meaningfully adequate. However, actors may interpret such an intervention as having perverse effects, and it is here that the methods chosen display an important strength. Such an interpretation should lead to the search for relevant causal data and where explanations are validated, to modified interventions.

Beyond its obvious methodological importance, the lengthy insistence on these points is grounded in a serious practical problem. To illustrate, we saw in Chapter 1 that the introduction and use of the Davy lamp in the workplace was associated with new accidents. In a contemporary context, interventions made in the name of accident prevention that do not consider the dynamics surrounding their insertion into the workplace, and these are always social, may do little to reduce accidents.

My empirical testing of hypotheses drawn from sociological theory cannot examine the details of other specialist disciplines such as engineering, physiology, or sociometry, because such details important to other disciplines could overshadow the testing of sociological hypotheses. Such a stance, however, may result in a number of accidents and phenomena being poorly explained. But the most important immediate task is the testing of the sociological theory. The validation of hypotheses drawn from sociological theory would present a challenge, one initiated in Chapter 3, to integrate specific teachings from non-sociological disciplines into the theory. Through such integration the

theory would be further refined as both a tool for analysis and as a guide to prevention. Through the translation of such teachings into languages capable of comprehension by social actors, a contribution could be made, perhaps in a manner analogous to that found with the slow historical emergence of industrial capitalists and industrial workers in Chapter 1, to the production of new meaning states, new cultural traditions, and new social actors. Furthermore, it should no longer be possible for any discipline to envisage production and prevention without taking actor's meaning states into account. Recent developments in ergonomics, medicine, and engineering lead to a perception that segments of these disciplines are already making moves in such a direction. Such moves were depicted in an embryonic form in Chapter 2 and shall be further discussed in Chapter 6. Should such a process deepen, the limits of the traditional views of accident prevention, ones based in antisociological causal models of human behavior, would become all the more visible.

Sociological Analysis of Empirical Accidents

In recent years there has been an important move toward viewing accidents as having multiple causes. From the viewpoint of hypothesis testing, such an approach has a major potential weakness. When virtually everything can be seen as a cause of an accident, prevention efforts become extremely difficult to focus. To combat such a danger, the sociological perspective was developed to favor monocausal explanations. This is done without denying the possibility of multiple causes at the individual member or social levels. Thus, explanation searches for that causal relationship that would have resulted in the error being avoided, had it been absent.

I will illustrate this rather complex formula by referring to a hypothetical example. A worker with incomplete knowledge of the job, subject to both piecework and authoritarian management, is the victim of an accident. How does one decide at which level it was produced? A series of questions that eliminate some causal hypotheses and sustain others must be asked. Schematically, in this case, a first question might be: did the worker know how to safely perform the task which resulted in injury? If the response is affirmative, then underqualification cannot be the cause. If negative, then it may have been the cause. The victim could conceivably be interviewed to obtain necessary clarification as to the state of knowledge of the task and orientations toward it. In order to determine the accuracy of the interviewee's information, it should always be compared with that provided by peers. This methodological

point reflects a theoretical one: the "individual" is situated in and acts in a social context.

The worker may assert that authoritarianism was the cause of the accident. Should workmates accept that this approach is used to manage work but reject the notion that it produces dangerous actions, strong grounds for rejecting the victim's explanation as lacking in meaning adequacy are provided. Clearly, other tentative explanations are to be evaluated in the same manner. The research process involves a continual sifting between levels, whether social or nonsocial, to construct explanations of given accidents. Only in rare cases will more than one direct cause for a given accident be isolated by this process. None of this means that accidents are a simple phenomenon, since a variety of social relations may underlie any given accident. In the hypothetical example under discussion, the use of piecework may have resulted in those responsible for on-the-job training preferring piece-remunerated work activities to hourly remunerated training activities. In such a case, the direct cause of the hypothetical accident could be the underqualification of victims, but never could be the financial incentives paid to their (supposed) trainers. In this manner, successful prevention could be seen to lie in the elimination of worker underqualification through strategies such as specialized training, the introduction of incentives for trainers, or a reduction in the content of tasks. These are but three possible strategies aimed at eliminating the cause of the accident.

Conclusion: Criteria of Explanation

Having explored how accidents should be examined as being produced monocausally, and how explanations are only considered valid if they are causally and meaningfully adequate, the establishment of criteria for research design can now occupy our attention.

RESEARCH DESIGN

Background Discussion

Research to test hypotheses drawn from a theory can be carried out, according to Crozier, using either a structural or a case study approach.[9] At this stage it is very difficult to perceive of how the theory of accidents, as developed, might lend itself to a general test using a structural study approach. A key reason for this is a theoretical one.

Sociology claims a long and honored tradition of structural studies

in many areas. Regarding error in general, and accidents in particular, this approach has led to many contradictory findings and can now be evaluated as having serious difficulties. However, this should not be read as suggesting that sociology has nothing to say about such questions, but rather, that it must engage in considerable theoretical work in order to reconceptualize the problems under investigation. Chapter 3 was written in such a spirit.

This being said, it can hardly come as a surprise that the general idea of "structure" and "structural variables" found in the theory of accidents is quite different from that which has played such a dominant role in the sociological tradition. In the course of building the theory, certain phenomena, commonly considered to be "structural determinants" of accident rates, were examined: unions, training, piecework, safety committees, safety equipment, and so on. In each case it was suggested that their role could be understood only by examining their insertion in the workplace; furthermore, the sociological theory of accidents was suggested as a tool for such analysis. For the sociological theory to be systematically used in such a manner, the construction of precise notions as to how each intervention translates into social relations, and then plays a role in accident production or prevention, is necessary. In this way a series of new, item-specific, structural studies might be able to be built up. It is presumptuous to think, however, given the present state of theoretical development and empirical research, that the general hypotheses made can be validated merely by linking series of item-specific studies.

The general hypotheses that were derived from the theory require testing. The barriers to testing them using a structural approach appear to be considerable: resources, access to study sites, and the need to compose interdisciplinary teams are but a few. The clearest barrier, which has already been discussed in a far more specific context, is a conceptual one: such testing would require that work relations, with all their complexities, interactions, and capacities for self-transformation, be somehow converted into general "structural variables." If I considered that we are distant from a situation in which item-specific studies could be used as a basis from which to work toward general tests, we are much farther away from breaking down this general conceptual barrier.

In the case study approach hypotheses drawn from the sociological theory are tested through research into specific organizations. In this manner, an understanding of the functioning of and interrelationships between all social relations found in the organizations are examined and their links to error production developed. The critical weakness of this approach is that one cannot generalize from such studies. This weak-

ness manifested itself clearly in the first New Zealand case study I conducted. Although the results were compatible with sociological understandings of work, they provided no indication as to the wider generalizability of the findings for accidents. I had hoped that follow-up studies in a series of French construction sites would permit some tentative generalizations about construction accidents.[10] However, the variety of techniques used, of management styles, of degrees of union presence, and of workforce compositions to be found in each meant that it was impossible to control for such influences. In this manner the studies did not permit the building of a clear and unequivocal picture of the role of social relations. They simply provided a strong indication of the wide applicability of a sociological approach to accidents.

The sociological theory built lends itself, at this stage of its development and the development of structural studies in general, far more readily to testing through case studies than structural studies. Such studies have also demonstrated a capacity to furnish rich and unorthodox pictures of the relationship between the management of work and the production of accidents. For these reasons, the decision to continue with a case study approach imposes itself.

In order to overcome the limitations of the French studies, I considered that further research would need to be designed to include controls. This suggested two courses of action: (1) to abandon research in the uncontrolled and semicraft world of the construction sector and to move toward manufacturing industries, and (2) the necessity of designing a study to permit different cases to be closely compared.

Most people do not like to admit responsibility for errors. This is especially so when court cases can follow (as in the case of medical error), where reputations are at stake (as in the case of schools), and where external forces may use indices of error as a pretext for intervention (as in the case of accidents, through factory head offices, and government safety inspections). Add to these ingredients the fact that records are usually kept according administrative and not sociological research criteria and we arrive at a situation where the measurement of the dependent variable in testing any theory of error production becomes a problematic affair. In the construction sites I researched, record-keeping practices made it far more difficult to obtain measures of the dependent variables—accident types and rates—than to gather data about the independent variables through interviewing staff and observing work. In a few cases some accident reports had been transferred to head office; in others, they had simply disappeared—in one case I found some in the wastepaper basket! Where subcontractors or temporary workers were engaged, these problems were aggravated.[11] Accident

rates were thus underreported, and an important resource for the verification of interview data unavailable. When available, accident reports sometimes proved inadequate. Frequently, when accident reports were written out by foremen, they blamed, almost ritually, worker carelessness.[12] Some forms were filled in so that crucial elements of the accident were hidden, which was discovered in interviews. In addition, due to legal controls on working hours, the reported statistics could severely underestimate the hours that were in fact worked. Clearly, further research should seek to surmount such deficiencies.

These reflections, coupled with discussions in Chapter 3, combine to produce a list of three criteria to be met in study design and in the choice of research sites. While these were developed in a manner specific to research into accidents, they constitute criteria for the execution of controlled case studies which have more general relevance.

1. Study design should permit important variables to be controlled for in such a way as to facilitate the clear and systematic interconnection of case studies. (Nonsocial variables such as technology or individual psychology should be controlled for at the same time as social relations.)
2. A wide variety of workplaces should be studied. (This choice should be made in such a way as to relate back to the fields of the sociology of work and management studies.)
3. Adequate accident reporting systems should exist in the workplaces chosen.

Case study research that attempts to introduce relatively tight controls can be found in Dubet, Cousin, and Guillemet's recent research into school failure, and in Barley's study on the introduction of technology in hospital radiology units.[13] Such studies may represent part of a growing attempt to introduce controls into nonexperimental sociological case studies performed in natural settings.

The Criterion of Variable Control

The Search for an Experimental Study

Variable control is one of sociology's knottiest problems. From a methodological viewpoint, the best test of hypotheses drawn from the theory would be provided by a classic "pretest-posttest one control group" study.[14] Such a design requires that investigations be carried out in pairs, to ensure that nonsocial variables, such as technological and psychological ones, are controlled for. For example, two worksites, with

similar technical and psychological profiles, could be selected. Using a case study method, a first general hypothesis could be tested: that accidents are produced socially. Should this be verified, and similar patterns of social relations and accident production found in both workplaces, a further hypothesis derived from the theory could be tested: that accidents are to be reduced by introducing specific changes in social relations. In keeping with the test design, changes in social relations could be introduced in one workplace, and impact monitored against performance in the unchanged workplace. This procedure could be repeated in any number of "matched pairs" of workplaces. Monitoring would serve to validate or invalidate the hypothesis. The replication of results in a variety of workplaces would provide generalized support or refutation of the hypotheses drawn from the theory.

Traditionally, organizational theory experimentally tests its hypotheses in artificial laboratory situations or relies on uncontrolled "real-life" studies. From the methodologist's viewpoint it is unfortunate that experimental studies in real workplaces—hospitals, department stores, factories—are an extremely rare phenomenon. Such difficulties are not confined only to researchers from the academic world; even Frederic Winslow Taylor, whose theories were to dominate thought about the rationalization of work for over half a century, met with consistent and effective managerial and worker opposition to the experimental introduction of his pioneering work methods. This occurred in spite of the fact that his ideas were sold with the promise that they would increase both efficiency and wages.[15] Given the financial interests of both parties in such goals, how could Taylor have failed? And, given his failure, how could any average researcher expect to do better when launching into an area as sensitive as the investigation of accidents?

As if this discouraging question were not enough, other writers have concluded that it is impossible to develop the types of controls necessary to ensure, for example, that different people are exposed to similar risks. In designing their study, which sought to examine the relationship between piecework and accidents, Wrench and Lee stated:

> Even if all other relevant variables could be held constant (a possibility in theory only) a higher rate of accidents among pieceworkers could simply be due to the fact that (say) pieceworkers tend to work on the sort of tasks which are intrinsically more dangerous than those of dayworkers. It is therefore important to attempt to equate risks in any comparison of the distribution of accidents between different groups; however, in practice [they conclude referring to Hale and Hale's literature review] this is virtually impossible.[16]

One experimental accident study was started in United States coal mines. In it, researchers sought to compare the performance, especially that related to safety, of autonomous and nonautonomous groups. The

considerable academic prestige of project leader Eric Trist and the political context of preoccupation over mining accidents no doubt had been of help in his obtaining management and union support for the research. However, the study was abandoned midcourse as a result of a worker vote in one mine.[17]

Desirable as an experimental design in a natural setting might be from a methodological viewpoint, in practice it appears extremely difficult to execute. This conclusion forced me to look elsewhere in order to devise an adequate test.

Rereading the Literature

A rereading of the literature revealed at least one potentially fruitful field for research: rotating shift work provides spontaneous controls over psychological and technological factors. Studies show, however, that the same workers exposed to the same risks can suffer accident rates that vary between day and night shifts. No widely accepted explanation has been developed for these differences, the underlying problem being that rates are higher in some factories on night shift and in others on day.[18]

Engineers and psychologists do not generally discuss rotating shift work. This silence is a logical outcome of their incapacity to explain variations in accidents when machines, materials, and the work force remain the same. Medical researchers' notions that accidents will necessarily be more frequent at night due to fatigue have been contested by an alternative medical explanation that attributes lower nighttime accident rates to the "reduction of superior nervous activity."[19]

The reader might join this writer in naively asking what form of social relation could be associated with a reduction of "superior nervous activity"? While such a question may be incorrect from a medical point of view, a congruent tentative sociological explanation has been formulated in Hill and Trist's study: there night shift workers were seen to suffer fewer accidents because they were subject to fewer supervisory pressures than on day shift. Such an explanation generates, consistent with the theory developed in the previous chapter, a symmetrical hypothesis: should supervisory pressure increase on night shift, accidents would increase.[20]

This unique sociological explanation of lowered accident rates, and the derived hypothesis, led me to perceive that rotating shift work may, in fact, be a form of spontaneous semiexperiment. Subject to similar risks, the same workers may have their relationships to the dangers of their work managed by different social relations on each shift.

On the basis of this reflection, I chose to investigate factories where rotating shift systems were used. To introduce a further variant on the semiexperimental nature of the choice, I decided to include some fixed-shift workplaces. In the latter, machinery and products remained the same between shifts but the work force varied. One source of such variation, from a sociological viewpoint, might link the dissimilar recruitment patterns found for permanent day and night workers, these translating into differentially constructed knowledge, collective power, and types of orientation. Where such differences occur, variations in accidents between shifts could, if hypotheses drawn from the sociological theory are valid, be expected to occur.

Potentially, then, a study of shift work would fulfill the first criterion developed: that its design permit the control of variables judged important by nonsociological theoretical systems, thereby permitting the close investigation necessary to test sociological hypotheses.

The Criterion of Variety

Organizational Level

A variety of work sites should be studied, but should be chosen in a systematic fashion. One basis for such a choice would be to consider a number of key theoretical preoccupations expressed in analyses of work, and to opt for workplaces that exhibit systematic variations in these. In this way the analysis of accident production can be tied in to key theoretical issues in organization theory.

Three levels at which people's relationships to their work are managed were treated in the previous chapter: organization, command, and rewards. By choosing a variety of organizations that cross different technological and managerial systems, a study would gain new controls that might permit it to lay claim to a certain generalizability. The discussion of technology relates most closely, as we saw, to organizational level considerations—different technological systems are associated with distinct labor force characteristics and systems of task structure and coordination. Touraine divides technological development into three phases. The first corresponds to craft production, the second to semimechanized and assembly-line work, and the third to continuous process industry.[21] One question that could be considered relevant is whether technologies that correspond to different phases are associated with different patterns of error production and, in this particular case, accidents?

I decided to include plants in which the major production activity can be characterized as belonging to each phase.

Command and Rewards Levels

One of the common treatments of management style in organizational theory relates to the command level and sees the amount of autonomy that different styles permit workers as a key variable for investigation. A prominent example of this approach is McGregor's Theory X and Theory Y, and another is found in the distinction drawn by Andrew Friedman between direct control and responsible autonomy.[22] My original decision to investigate shift work was, in part, propelled by Hill and Trist's observation that the intensity of managerial supervision, and hence the margin for the exercise of worker autonomy, changes between day and night shifts.

It is quite easy for a traditional concept like "management style" to integrate considerations relating to employer action at the rewards and command levels. To use a popular image, management strategy frequently vascillates between the "carrot" of financial rewards and the "stick" of authoritarianism.[23] The success of authoritarianism is commonly correlated with the absence of effective trade unions. In this way the absence of unions can be taken as one potential indicator of the use of "the stick" in a plant. In a similar vein the presence of a rewards-for-effort system may be taken as an indicator that "the carrot" is used to manage work.

Only by penetrating into the workplace can the actual effects of different externally assessed indicators on social relations be perceived. The researcher is obliged to use such indicators to help decide the most appropriate research sites. In terms of this discussion, four kinds of workplace management style are logically possible: those with trade unions, with or without financial incentives, and those without unions, with or without financial incentives. By choosing plants with contrasting management styles, one can ask: What are the effects of the existence of different styles, defined in structural and not social terms, for the production of error?

Ensuring Variety

The criterion of variety is met by ensuring that organizations of a limited number of technological types and management styles are examined in turn. In this way comparisons can be made between industrial plants of similar technological types but different management styles and between plants of different types but similar styles. By choosing plants on this basis, a variety of hypotheses will be able to be tested and, hopefully, a clearer understanding of the relationships between tech-

nological types, management styles, and the production on accidents obtained.

The Criterion of Adequacy

Both the central employer and central trade union organizations in New Zealand were interested in the social consequences of shift work, and for this reason provided backing for the study. The research was executed with funding from the Research and Planning Division of the New Zealand Department of Labour.

The national New Zealand Manufacturer's association indicated plants where shifts were worked and the technological processes employed therein, and expressed its opinion as to potential employer receptivity to research. Because of the country's size, only a small number of plants fitted the bill. A list of plants in diverse geographical locations was eventually drawn up. An initial phone call was made to assess the accuracy of information provided by the Manufacturers' Association, and to gather preliminary information about "management styles" and record keeping. Fourteen plants were selected for follow-up visits. Such visits, beyond permitting a closer check on information previously obtained, served to expose the practical aims of the study, to acquaint factory management and union personnel with the study, and to seek their cooperation. In three plants, initial criteria were not met: in one because regular night shifts were not worked and in two management demanded the right to handpick interviewees.

Research commenced in 11 plants and was eventually abandoned in 4. In a plant using semimechanized technology, night shift tasks proved incomparable with those found on day shift. In another plant, the small staff worked in extreme isolation from one another; thus, adequate observation of work proved impossible. The decision to abandon this plant reduced the sample of continuous process technology plants to one. In two further cases, both in the recession-hit textile industry, partially completed research had to be halted as a result of night shifts being closed down.

Of the 14 preselected plants, the study was completed in only 7. In four plants subject to rotating shifts, pairs of plants, with dominant productive processes being in craft and semimechanized phases, were researched. In each pair contrasting management styles were used. In a fifth plant, production centered around a form of continuous process technology. Management style in two plants linked the presence of financial incentives and the absence of effective trade unions (trade union

membership is compulsory in New Zealand, but in some plants unions were not implanted on the shop floor). By contrast, in the remaining three, financial incentives were nonexistent and unions influential. Fixed shifts were employed in a further two semimechanized plants, both subject to a management style that combined the presence of financial incentives and strong trade unions.

To investigate errors as a dependent variable, one can describe them in individual detail as do journalistic and some sociological texts on medical error, or one can try to develop aggregate measures. The dependent variable in this study is industrial accidents, and their incidence is expressed in the form of rates of accident with lost working time. Three orders of problem can be encountered with this variable: measurement, socially produced rates, and the selected measure's distortion of the phenomenon.

Variable Definition and Problem Distortion

If school failure were defined with reference only to the results of Scholastic Aptitude Tests, the approach taken to its prevention might be quite different from that implemented if the measure were dropout rates. In relation to accidents, Shannon provides the following insight: "It seems that accidents of one severity only will yield a false view of the overall pattern of accidents and will not necessarily enable preventive measures to be derived for all types of accidents."[24] The concentration on accidents that result in at least a complete shift period off work and the victim's entitlement to compensation (the definition of lost-time accidents used in this study)[25] produces a problem; if accidents resulting in a week or an hour off work were the focus, elements of analysis might be different. Lost-time accidents are focused upon because they have a certain "objectivity"—reflected in physical injury—and are normally subjected to detailed analysis, control, and documentation. This objectivity means that social and individual member factors are less capable of influencing reporting than they are with non-lost-time accidents. Accidents of greater severity merit special attention, but to concentrate on them alone would be to ignore a significant source of suffering and loss. In a given workplace, Shannon's analysis suggests that severe accidents may have sociologically different causes from nonsevere ones. Such a notion merits investigation, and in particular sociological investigation, but lies outside present objectives: to provide a general test of hypotheses derived from the sociological theory of industrial accidents.

Socially Produced Accident Statistics

Some of the factors that lead to variations in the report rates for comparable accidents have been mentioned previously and have been analyzed from sociological perspectives by writers such as Baldamus and Hill and Trist.[26] Nichols has criticized this emphasis. He argues that people are physically injured through the production of real accidents and that this major social problem has been insufficiently studied by sociologists. It therefore makes little sense to give priority to what is a comparatively minor question: the social production of accident statistics.[27] A researcher should not ignore the influence of the factors outlined by the former authors because their influence on reporting may distort measurements of the dependent variable between shifts in the same factory or between factories. In the course of research, such influences would be noted and not judged significant.

Measurement

Measurement constitutes the third problem identified. It manifests itself in the calculation of shifts worked and in the release of accident data by plant management. In spite of having received guarantees prior to research that all plants kept certain standardized and accurate records and that relevant data were readily available, this did not prove to be true. Reliable data on the number of days lost per accident was not available in some cases, this meant that questions relating to differential accident severities could not be examined. In one plant accident registers were incomplete due to local management's wish to avoid the attention of its international head office safety and efficiency staff. In some plants information pertaining to the time worked was available only on an approximate basis. However, on day and night shifts, different from afternoon shifts, any measurement errors were seen by administrative staff as being consistent. Evidence contrary to this evaluation was not found.

In researching the production of industrial accidents, interviews not only allow the meaning adequacy of causal explanations to be tested but they also permit information on the accuracy of causal data to be gathered and questioned. Where necessary, original sources can be returned to for verification or correction. This process occurred throughout the course of research.

In spite of the difficulties experienced with the dependent variable and the abandoning of research in certain plants, the criterion of adequacy can be considered fulfilled in an acceptable manner in the re-

search. The lack of data on severity and of a second continuous process plant in the sample of factories, however, constitute weaknesses.

CONCLUSION

Satisfactory results of hypothesis testing would confirm the potential usefulness of a new analytical tool for understanding industrial accidents, their production and prevention. Any such results would challenge members of those disciplines which currently dominate accident prevention to incorporate sociological perspectives into their diagnoses and practices. Should this occur, a process could begin whereby a sociology of industrial accidents would be constructed and refined by developing a deeper understanding of these disciplines and their ramifications for it. On a more general level, sociology as a discipline could, through its various subbranches, be challenged to produce more subtle understandings of the roles and actions of the disciplines, professionals, and government agents. Finally, a demonstration of the strength of this sociological theory could challenge researchers to draw any relevant lessons for their conceptualization and investigation of other forms of socially produced error.

NOTES

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5. A. Schutz. 1979. *Fenomenologia e Relacoes Sociais,* p. 311. Rio de Janeiro: Zahar (compiled by H. R. Wagner).
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8. Schutz, 1967, p. 231. My interpretation of the notions of causal and meaning adequacy is one of the earliest reflections in this book. Throughout the course of 1990 my research was directed at producing a sociological basis for limited interdisciplinary dialogues in the area of work studies. This research examines relationships between engineering, medicine, psychology, ergonomics, and sociology. It has brought about modifications in my understanding of the contribution that phenomenology in general, and Schutz's writings in particular, can make to interdisciplinary dialogues.
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12. Deveze, 1979, p. 37; the author relates that workers who describe dangerous acts do so by questioning work organization, while experts refer to the imprudence or shortcomings of workers.
13. F. Dubet, O. Cousin, and J.-P. Guillemet. 1989. Mobilisation des etablissements et performances scolaires. *Revue Française de Sociologie* 30:235–256. S. Barley. 1986. Technology as an occasion for structuring: Evidence from the observation of C.T. scanners and the social order of radiology departments. *Administrative Science Quarterly* 31:78–108.
14. Denzin, 1970, pp. 149ff.
15. D. Nelson. 1984. Le taylorisme dans l'industrie Americaine, 1900–1930, in M. de Montmillion and O. Pastre (eds.), *Le Taylorisme*, pp. 51–66. Paris: Decouverte.
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22. D. McGregor. 1960. *The Human Side of Enterprise*. New York: McGraw-Hill. A. L. Friedman. 1977. *Industry and Labour*, chaps. 7 and 8. London and Basingstoke: Macmillan.
23. A. Salpukas. 1990. Difficulties at Eastern traced to pressure to avoid delays. *New York Times*, July 31, pp. A1ff. The degree of popularity of these notions, and the linkage to the production of danger were discussed recently in this article. Eastern Airlines officials had been indicted on various charges of allowing false maintenance reports to be issued, which placed the public at risk. A pilot is quoted as seeing the risk as linked to the installation of a "carrot-and-stick approach". For example, a "manager of maintenance at Kennedy [airport] who met the company's goals for getting airplanes out on time would get extra money. If the supervisors and managers failed . . . they would face enormous pressure from above, including threat of transfer."

24. H. S. Shannon. 1980. Differences between lost-time and non-lost-time industrial accidents: *Journal of Occupational Accidents* 2:256–272 (p. 272).
25. In New Zealand companies pay the first week's compensation to workers, after which period the state run accident compensation scheme becomes responsible.
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5

Testing the Sociological Theory

INTRODUCTION

Four general discussions come together in this chapter: the workplaces to be examined are each a product of sociohistorical processes; professional and administrative institutional interventions in the workplaces in the name of safety are examined; hypotheses drawn from the sociological theory constructed in Chapter 3 are tested; and to do this, methods and study design discussed in Chapter 4 are called upon.

Sociohistorical Setting

The plants studied are all located in New Zealand, and were all founded at a time when this dependent nation resorted to a protectionist policy of "import-substituting industrialization" to guarantee autonomous economic development. Under such a policy the country experienced nearly four decades of full employment and relatively low indices of social inequality. Through legally compulsory membership, a trade union movement had expanded. An industrial managerial class, the interests of which were little related to competitiveness, was developed. In this general context the country's population, for the large part, had come to see itself (as of course do people in many countries) as living in a country unequaled on earth. Such developments were compatible with a national identity that emphasized the "do-it-yourself" approach, the pursuit of leisure, antielitism, and that was divided between a terrible sense of inferiority vis-à-vis the outside world and a pride and complacency, sometimes bearing on provincialism, with life in what was popularly called "Godzone."

The studies of shift work were carried out during a period (1979–

1980) when recognition of the lack of continued viability of the country's industrialization model was emerging. Such recognition had long been adjourned by overseas borrowing and big dreams of developmental "magic bullets." Under the justification that it would ease the country toward a more competitive position in world markets, industrial protection was being gradually removed at the same time as government-provided export incentives were paid. This redefinition of interests led to a new dynamism that was penetrating into the managerial elites. Significantly, all the plants in which research was completed were opening up export markets, and most were developing new products. Some plants had turned to shift work to keep up with demand. However, a new instability was pervading the country; unemployment was rising, and firms alternated between laying off workers and increasing working hours as demand fluctuated. Two plants where research had to be abandoned reflected these changes dramatically: a downturn in demand led to the discontinuation of night shifts.

This is an extremely quick sketch of a larger context within which the research was conducted. It was in this context that a series of institutional interventions in the name of industrial safety and health had been developed.

Institutional Interventions

Successive National (conservative) and Labour administrations had overseen the development of a society that sought to attain and maintain its relative social equality through state intervention in many spheres. Industrial safety legislation, mainly administered by the Department of Labour, was essentially imported from Great Britain. So, too, were legions of immigrants, some of whom would form an important part of the factory inspectorate.

Compensation for accidents is a completely different story. Wage-related compensation was paid, in a system unique in the world, to victims of both work- and non-work-related accidents without regard for fault. In return for such protection, victims lost the right to claim common-law damages. The system was funded in part by a payroll levy scaled according to the average risks of employment in a given sector; however, this levy did not take the actual performance of individual companies into account. The body that administered compensation, the Accident Compensation Commission, employed its own safety staff, which functioned in an advisory capacity to industry. Different from the factory inspectorate, their ideas and approaches to safety, based on a mixture of psychology, engineering, and total loss control (damage control), were imported from the United States.

Trade unions, with the exception of some officials, had largely abdicated an adversarial role regarding safety and compensation in their institutional activities, and their role was essentially confined to making political demands on the state. At the shop-floor level, union activism varied widely. In such a context, employers engaged various categories of safety professionals.

Doctors and nurses, with rare exceptions, did little more than patch up the injured. Ergonomics had yet to be introduced into workplaces. "Safety managers" were the key resource. In the course of my research, I interacted frequently with this category of professionals, most of whom had been recruited from engineering and some from personnel management or industrial psychology. All had been through specialist (again originating from the United States) safety courses, but no one, not even those who held full-time specialist safety positions, had undergone long-term formal training. Their levels of specialist qualification were markedly inferior to those of the safety professionals with whom I had interacted during my French construction research. Also contrasting with my French observations was the manner in which the New Zealanders' lack of specialist safety training, combined with a social context where both workers and managers held antielitist and "do-it-yourself" values, limited their capacity to act in the autonomous and professional manner of their French counterparts.

Like other industrial countries, New Zealand has foundries, and in the process of making billets, both iron and blood are produced. Institutions intervene in this process as do workers and employers. To the extent then that we can talk of industry and of an industrial culture, to the extent that theories of industrial work can be built, and to the extent that the hypotheses being tested are general, the lessons to be drawn from these studies have applicability beyond New Zealand.

Study Design and Methods

Hypotheses drawn from the theory were tested in seven plants. As discussed in Chapter 4, once a semiexperimental study design had been decided upon, the plants were selected as representative of certain technological types and management styles. Technologically their dominant production system ran from semicraft, through semimechanized, to continuous process production. "Management styles" were of three types: (1) compacted, where employers did not directly manage through the rewards level and workers exhibited strong collective organization at the command level; (2) traditional, where employers managed through the rewards level and workers were not collectively organized at the command level; and (3) induced, where employers managed through

Table 5–1
Characteristics of Plants and Variations in Accident Rates per 100,000 Person Shifts

	Technological type		
	Semiartisanal	Semimechanized	Continuous process
Compacted management	Plant A day = 103 night = 75	Plant C day = 63 night = 30	Plant B day = 43 night = 33
Traditional management	Plant D day = 103 night = 191	Plant E day = 26 night = 63	
Induced management		Plant F day = 32 night = 74 Plant G day = 40 night = 16	

the rewards level and workers were strongly organized at the command level. The seven plants and their accident rates are found in Table 5–1.

Before entering the plants I was aware of such features and that, since industrial night work was prohibited for women, only males (the exceptions being found on permanent day shift) could be employed therein. But, even armed with such information, I started my investigations with no concrete hypotheses as to what types of social relations I would find in the plants, what the roles of safety professionals would be, or what the variations in accident rates between shifts would be. I simply had no prior idea as to which of the many specific hypotheses that can be derived from Chapter 3 were going to be tested.

I did, however, have a series of intuitions: I imagined that the changes in these plants between day and night shift would be of such an order as to alter patterns of accident production. I envisaged that the information obtained in the study would be such as to permit the four following general hypotheses developed in Chapter 3 to be tested in a qualitative manner:

1. That social relations of work produce industrial accidents.
2. The greater the weight of a level in the management of workers' relationships to the dangers of their jobs, the greater the proportion of accidents produced at that level.
3. The greater the influence of managerial safety management at a

level, the lower the proportion of accidents produced at the level the management action seeks to control.

4. The greater the degree of autocontrol by workers at a level, the lower the proportion of accidents produced at the level the worker action seeks to control.

These hypotheses are sufficiently general in nature to permit the derivation of multiple hypotheses about specific aspects of social relations at each level, their functioning and change.

During a five-month period I went from plant to plant, observing work, interviewing staff at all levels, revising accident records, making preliminary analyses, and returning to validate them; over two full working months were spent in the field frequently entering plants in the mornings or leaving at dawn. I came to develop some quite unanticipated insights and appreciations. In this way the study results, even if they only address a small part of the range of hypotheses that can be derived from the sociological theory, do so in a manner that reflects the reality of the plants examined and the limitations of the methods used.

Using the Sociological Theory

In this chapter three shift work studies are detailed. They are written in such a way as to reflect what goes on "on the ground" in industrial production, and how seemingly subtle changes in social relations can have major consequences on working life and on the production of accidents. A preliminary presentation of all seven studies has been published elsewhere.[1]

Even if my idea of what I was going to find out was unclear, I did have a very definite idea of what I was *not* going to investigate in detail. I had no intention of attempting to understand each plant as a product of diachronic change and its accident rates as a consequence of this. Nor was it my intention to spend time investigating the successes or failures of conventional approaches to safety management. Instead, with respect to this, I would note the presence or absence of features of conventional approaches and use this information in future elaboration of general statistical tests of the influences of a range of structural factors on safety. Information on such factors, even though sometimes presented in a relatively basic form, is depicted in Table 5–2. Thus, variables included are measures of organizational factors gathered on the basis of company records (Table 5.2, v5–v9), measures of degrees of institutionalized safety interventions gathered through interviews and company records (v19–v23), appreciations of diverse measures of plant danger based on

Table 5–2
Conventional and Sociological Variables for Testing

	Plant A		Plant B		Plant C		Plant D		Plant E		Plant F		Plant G	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Shift: Day = 1 Night = 2 : V.1	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Process type: V.2	1	1	3	3	2	2	1	1	2	2	2	2	2	2
Shift type: 1 = rotating 2 = fixed : V.3	1	1	1	1	1	1	1	1	1	1	2	2	2	2
Strike rate: V.4	1	1	3	3	1	1	3	3	3	3	2	2	1	1
Labor turnover (1): V.5	2	2	2	2	2	2	1	1	1	1	2	1	2	1
Labor turnover (2): V.6	1	1	1	1	2	2	9	9	7	7	2	4	3	5
Span of control (1): V.7	18	16	17	14	11	13	14	13	20	18	13	13	18	29
Span of control (2) V.8	6	16	9	14	5	13	5	13	5	18	8	13	12	29
Number of staff: V.9	42	33	38	30	39	27	17	14	25	19	44	28	78	60
Potential cost of accidents: V.10	1	1	1	1	2	2	1	1	2	2	3	3	2	2
Productivity: V.11	3	1	2	2	3	1	2	2	3	1	2	2	1	3
Age of staff: V.12	2	2	2	2	2	2	2	2	2	2	3	1	3	1
Financial incentives: V.13	1	1	1	1	1	1	2	2	2	2	2	2	2	2
Control style: V.14	1	1	1	1	1	1	2	2	2	2	3	3	3	3
Physical danger: V.15	7	7	2	2	4	4	6	6	5	5	1	1	3	3
Danger of materials: V.16	7	7	3	3	5	5	6	6	4	4	1	1	2	2
Safety devices: V.17	6	6	1	1	4	4	7	7	5	5	2	2	3	3
Danger of process: V.18	2	2	1	1	1	1	2	2	1	1	1	1	2	2
Government inspection: V.19	3	3	3	3	3	3	1	1	1	1	2	2	2	2
Safety officers: V.20	1	1	1	1	1	1	2	2	2	2	2	2	2	2
Safety committees: V.21	3	3	1	1	1	1	3	3	3	3	2	2	2	2
First aid: V.22	2	1	2	1	2	1	1	3	1	3	1	2	1	2

Union and safety: V.23	1	1	2	2	1	1	3	3	3	3	1	1	1	1
Qualifications: V.24	1	1	2	2	2	2	1	1	2	2	2	2	1	1
Training: V.25	2	2	2	2	2	2	1	1	1	1	1	1	1	1
Social derivatives														
Employee control: V.26	2	1	2	1	2	1	2	2	2	2	1	2	2	1
Workers + incentives: V.27	0	0	0	0	0	0	2	3	2	3	1	3	3	1
Social relations + Im														
Organizational level: V.28	2	1	2	1	2	1	1	2	1	2	1	2	2	1
Command level: V.29	2	1	2	1	2	1	2	1	2	1	2	1	2	1
Rewards level: V.30	2	1	2	1	2	1	1	2	1	2	1	2	2	1
Individual member level: V.31	1	2	1	2	1	2	1	2	1	2	1	2	2	1

VARIABLE DESCRIPTIONS: *Variable 1*. Shift: 1 = day, 2 = night. *Variable 2*. Process type: 1 = process type A (semiartisanal), 2 = process type B (semimechanized), 3 = process type C (continuous process). *Variable 3*. Shift type: 1 = rotating, 2 = fixed. *Variable 4*. Strike rate: 1 = higher, 2 = medium, 3 = lower. Interview and (where available) statistical data were used to arrive at the ranking. (It represents differences between plants, and assumes identical treatment between shifts in the same plant.) *Variable 5*. Labor turnover (1): 1 = higher, 2 = lower; permits comparisons between shifts and between plants. *Variable 6*. Labor turnover (2): expressed in terms of the annual percentage of the workforce, e.g., 3 = 30 percent. *Variable 7*. Span of control (1): number of workers for each floor foreman. *Variable 8*. Span of control (2): number of workers for each foreman or other member of managerial staff normally located in the plant. *Variable 9*. Number of staff: the figure given is the number of workers, foremen, and managers employed. *Variable 10*. Potential cost of accidents: 1 = high, 2 = medium, 3 = low; the measures are relative between the plants. *Variable 11*. Productivity: 1 = higher, 2 = same, 3 = lower; measures comparison between shifts in the same plant based on interviews and records. *Variable 12*. Age of staff: 1 = higher, 2 = same, 3 = lower; values reflect the differences between shifts in same plant. *Variable 13*. Financial incentives: 1 = nonexistent, 2 = existent. *Variable 14*. Control style: 1 = compacted management, 2 = traditional management, 3 = induced management. *Variable 15*. Physical danger: 1 = least dangerous, 7 = most dangerous. The seven plants are ranked on the basis of a combination of observational and interview data. The overall dangers of products, processes, etc. are reflected in this measure. *Variable 16*. Danger of materials: 1 = least dangerous, 7 = most dangerous. The principal materials used are ranked on the same basis as v.15. *Variable 17*. Safety devices: 1 = most safety devices, 7 = least safety devices. The ranking is based on the researcher's assessment as to the extent to which plant or machinery design keeps workers "at a distance" from potential dangers. *Variable 18*. Danger of process: 1 = low, 2 = high. A forced choice in which the relative dangers of the main production process are recorded. *Variable 19*. Government inspection: 1 = above average, 2 = average, 3 = below average. Based on interview data referring to the relative frequency of Department of Labour inspection. *Variable 20*. Safety officers: 1 = specialist, 2 = nonspecialist. All plants are overseen by safety officers; this variable distinguishes their function. *Variable 21*. Safety committees: 1 = safety committee exists and is judged (via interviews with workers) effective, 2 = safety committee exists and is judged ineffective, 3 = safety committee does not exist. *Variable 22*. First aid: 1 = above average, 2 = average, 3 = below average. The researcher's rating based on observation of differential services between both shifts and plants. *Variable 23*. Union and safety: 1 = active, 2 = average, 3 = inactive. This index was calculated on the basis of interview data on perceptions of union involvement in safety. *Variable 24*. Qualifications: 1 = higher qualifications required to perform work adequately, 2 = lower qualification is required. *Variable 25*. Training: 1 = formal training schemes exist, 2 = formal training schemes do not exist. (Plant C coded as 2 because formal training was not available for most of the period researched.) *Variable 26*. Employee control: 1 = high control, 2 = low control. The values expressed represent a response to the question: To what extent do workers control their own work relations in terms of an orientation whereby they seek to reduce accidents? Observational and interview data are used to form the measure. *Variable 27*. Workers and incentives: 0 = not applicable, 1 = incentives offered and workers do not accept working dangerously to earn them, 2 = incentives offered and workers accept working dangerously to earn them, but their actions are held in check by employer authority, 3 = incentives are offered and workers act dangerously to earn them; assessed on the basis of interview and observational data. *Variable 28*. Organizational level: 1 = lower, 2 = higher; the values are relative between two shifts in the same plant. The attribution is made on the assumption that each level will dominate the functioning of work to a greater extent on one shift than on another, i.e. it constitutes a 'forced choice.' The value attributed is based on observational and interview data. *Variable 29*. Command level. Same as Variable 28. *Variable 30*. Rewards level. Same as Variable 28. *Variable 31*. Individual member level. Same as Variable 28.

interview and observational data (v15–v18), and, in the spirit of damage control, potential accident costs (v10). Variables 19–23 relate to traditional approaches to safety: relative frequency of government inspection (v19), the type of staff engaged in the formal safety management function (this is very different from safety management as defined in terms of the sociological theory) (v20), the operation of formal safety committees (v21), a measure of the role of industrial medicine (v22), and the perception of union roles in safety (v23). Strike rates, productivity, age of the work force, financial inducements, qualifications, training, and type of shift system are further variables of a structural nature that, in parts of the literature, are associated with accidents. Variables derived from the sociological theory are also expressed (v26–v31).

From the viewpoint of the sociological theory, such variables become relevant when they interpenetrate into work relations, and when this has a causally and meaningfully adequate relationship to observed accidents. This will be illustrated in the case studies. A whole series of variables were thus accounted for in the course of the study. They were not investigated in the same depth as the sociologically derived variables; however, all will be introduced into the statistical tests found toward the end of this chapter.

The general hypothesis that the greater the weight of a level in managing workers' relationships to the dangers of their jobs, the greater would be the proportion of accidents produced at that level, is capable of being transferred to specific social relations and, even, to specific aspects of social relations. In Chapter 3, I have referred to different types of disorganization, some that are capable of being perceived through normal human cognition and others that appear incapable of being so perceived. In the course of research new dimensions to the theory may emerge in the form of specific hypotheses; for example, the major sociological hypotheses that were derived for statistical testing only emerged in their final general form toward the end of the investigative process.

Introducing the Qualitative Studies

Finally, the previous chapter's discussion enters into this chapter. The study designed, and the plants researched, the time comes to write. In order to give some qualitative feel of the plants and how they function, I have decided to include short accounts about three of them. All three have been characterized as belonging to the same technological type, semimechanized production. Two plants were chosen because they use rotating shift work yet exhibit different management styles and

totally different patterns of social relations. In the third plant, a further management style is used and fixed shifts are worked. These qualitative studies should transmit to the reader some idea of the complexity of work relations and, through this, of the production of accidents when viewed from a sociological perspective. In a subsequent section, data from all seven plants researched are brought together and subjected to statistical tests in which a range of sociologically and nonsociologically derived hypotheses are tested. The sociological ones, and a more general one which is sociohistorical in nature, are found to have the most power for explaining variations in accident rates.

HYPOTHESIS TESTING: QUALITATIVE RESEARCH

The Pipe Plant: Plant C, Compacted Management, Rotating Shifts

The screaming and wailing of machines imprisoned in a gray somber environment provides the initial impression of this plant. On entering it, the afternoon's sea breeze, the day's colors, and the noise of traffic mixed with the squawks of seagulls are left behind.

The factory walls run some 150 meters in length, 80 in width, and 12 in height. The ensemble most reminds one of an old warehouse; this resemblance is made all the more striking by the coils of steel and stacks of finished and semifinished pipe that dwarf the men and forklifts nearby. The whiff of acrid fumes, the unmistakable smell of machine oil, the whirr of moving machines, and, most of all, the noise, shatter any illusion, imaginable during downtime, that the building houses anything other than a factory.

I climb up to the mezzanine floor upon first entering the plant, but even from there it proves impossible to view the whole place. Piles of product and freight containers seem to be almost randomly scattered around the floor. The plant safety officer who accompanies me on this first part of the visit held open a door and we enter the quiet of the plant office. After being introduced to the foreman and manager, I am left alone for a few minutes as they sort out a series of problems relating to a machine breakdown. To help bide time, accident reports are thrust into my hand. I select one and it reads: "While getting off a rack Kenneway stepped on a piece of dunnage and twisted ankle." The report form contained the supervisor's recommendation as to the measures to avoid repetition: "[there's] not much that can be done. Kenneway is overweight and has bad ankles."

The accompanying accident checklist codes the injury as being due to "using equipment unsafely." The safety officer leaves the meeting to

join me and I express puzzlement at the classification given to this accident. In addition, I note that eight of the precoded causal categories on the checklist relate to "unsafe acts," two relate to the existence of "unsafe conditions," and there is a residual "miscellaneous" category. In different handwriting, on the same form, an alternative explanation of the accident is written: that the victim was working overtime and that the associated fatigue was the "real" cause. The checklist precludes such an explanation. Why, I inquire, do these lists imply that the majority of accidents are the worker's fault? "I guess it's those books on safety that start off from there," he replies.

In this way, accident causes were attributed on the basis of a pre-established criterion: a list that categorizes nearly 80 percent of possible causes as "unsafe acts." The plant manager later confessed: "We're asked to produce it [the accident report], we're not very happy about it, but we do it all the same." Before even starting my formal investigations, questions relating to industrial safety seemed charged with conflict.

The Plant

Steel pipes of varying lengths, strengths, thickness, and specifications for both domestic and international markets are produced. Thanks largely to tariff protections and export incentives, the plant operates at close to capacity. In addition, innovative marketing and product development have resulted in production being diversified into the area of specialized pipes, which has opened up new markets.

With respect to its markets, this plant is in a position that is entirely similar to the extrusion plant with which it will be compared. Both plants work shifts to meet demand, each produces in batches, the production processes are semiautomated and the services of semiskilled operators are required to run them.

Accident prevention in the pipe plant is the subject of three distinct formal interventions: those of a safety officer, a training officer, and a safety committee. In addition, a first aid service limits the consequences of accidents. Management justifies its investment in these activities by referring to their role in cost reduction. An external agent, the factory inspectorate, makes occasional visits to police adherence to work legislation. Officials from the state-Accident Compensation Corporation visit the plant sporadically and exercise a strictly advisory role.

The Shop Floor

Staff is divided into three distinct workgroups, each supervised by a foreman who in turn responds to a general foreman. The general fore-

man works only on days and reports to a plant manager. Two additional supervisory staff add to the ranks on day shifts, one of whom has specific responsibility for training. The three workgroups shall be called the mill group, the reprocessing group, and the dispatching group.

The mill group consists of eight semiskilled workers, most of whom are capable of interchanging jobs. At the entrance to the mill, heavy steel coils of varying gauges and widths stand chocked and await feeding, first into a cradle and then into the machine that will transform them into pipes. A flat metal band is fed from the coil, heated and bent by a series of rollers to form a circular, square, or rectangular shape of preselected dimensions. This shaped metal pipe then moves automatically into a part of the mill where a bead weld is applied to join its extremities and subsequently passes through a device that tapers the weld so that it is indistinguishable from the rest of the pipe. It stops only after a constantly whirring saw blade, one meter in diameter, has thrust out of its cage to slice it to appropriate lengths.

Six of the mill staff work at jobs that under normal conditions are routine in nature. Their rhythm is largely determined by that of the mill; for example, the activity of all workers is accelerated when thinner pipes are made and slows with thicker gauge pipes. Two mill operators have a nonroutine job and they work when their colleagues do not. For them it is "a lot easier when the machine's going . . . when it's down we've got to work." They, like their teammates, see themselves as "slaves to the machine."

The reprocessing group, made up of 16 men, ensures that this hollow piece of shaped steel (which has thus far been erroneously called "pipe") completes a series of journeys through various machines and processes that will transform it into a finished pipe. Remachining, cleaning, threading, galvanizing, and applying other protective coatings are the main processes that it may pass through after the first quality control.

This set of jobs is repetitive in nature and, different from the mill, varies little with different pipe types. The discontinuous nature of the processes involved leaves the men relatively free to set their own rhythm. In recent times these jobs have been made more interesting: a special production order requiring meticulous work at all stages had been won by the company. As a result, the "quality of the product [has been] increased, so now we've got a better job, blokes [slang for "the men"] feel they're achieving more." Or, as one worker put it, "We're making pipe now, before it was tube with a hole in it."

The dispatching group, as its name indicates, is mainly responsible for ensuring that the finished pipe is classified, sorted, stacked, and prepared for shipping to customers. On day shift this gang has eight

members, six of whom are engaged in dispatch and two operate a coil-making machine. The latter two workers and two dispatchers are on permanent day shift, at night the remaining dispatchers are under the command of the reprocessing foreman.

Dispatching tasks are routine in nature and of low status. At the time of my research, the task was complicated by the limited plant storage capacity coupled with high production levels, which was seen as producing unsafe stacking practices. "Here you don't stop the machine [the mill], you've just got to put the stuff anywhere, you've got no choice."

The considerable variety of distinct jobs encountered in this plant and the division of labor that lacked the rigid demarcations observed in many industrial plants, did not prove obstacles to research. On-site interviews were conducted on night and day shifts, all jobs were covered, and sociological analysis structured accordingly. I will first examine work relations at a general level before examining differences between day and night shifts.

Work Relations and Accidents

When asked to identify the main cause of accidents, plant manual workers pointed to tiredness, boredom, and poor maintenance. A lack of training was seen as having previously been a major cause, but this was considered to have improved over recent months. The presence of "people standing over you" was seen as an important factor in producing accidents. Such action by supervisors and managers was adjudged to make people nervous, resulting (in some circumstances) in the workers being "pushed" to produce.

Analysis of this plant indicates that extended work, disorganization, and routine work are the major accident-producing social relations. Accidents produced at the organizational level by underqualification appear to have been greatly reduced, because of a decline in labor turnover from 35 percent to 20 percent in the previous two years[2] and because of the recent increased emphasis on training programs in response to the demands from new markets and to managerial economy drives. "Now most people are properly trained; I wouldn't have said this before."

The majority of accidents can be analyzed as being produced at the organizational level. In spite of this, interview material indicates that the command level has considerable importance in maintaining a certain system of accident production, and it does this without having major direct responsibility for accidents. This insight merits a detailed explanation, and this shall be provided in due course.

One important factor in keeping accident rates down is the existence of a comparatively high level of autocommand. The workers have a strong feeling of collective identity and this has translated into an energetic trade union presence on the shop floor. The unity is not fragmented by rewards level relations such as financial incentives or symbolic recompense, management does not employ bonus systems, and interworker or group competition is all but absent. In this context strong workgroup orientations that favor "safety values" rather than company-oriented risk-taking "production values" have developed. Some might refer to these orientations as a part of a "workgroup culture." One implication is that management reluctance to act on complaints regarding safety, and in particular machine safety, may result in worker-led bans and subsequent work stoppage. The workers resent being forced to exert their command level power in this way, "we shouldn't have to black something to get it fixed."

Dangers originating in factors other than machinery, and in particular at the rewards and organizational levels, are recognized. At the former level overly tired workers are seen as producing accidents. Extended work is an accident-producing social relation for a very specific reason: management has adopted a strategy of extending work through resort to overtime in order to make up minimum staffing levels rather than to employ extra workers on a regular basis. In spite of their criticism of extended work as a producer of accidents, most workers put aside their "safety values" and, in function of financial interests, willingly accept both the risks and rewards it entails. Underqualification is criticized by workers but, as has already been seen, it has recently been combated by management. Management has shown less sensitivity to the relation of routine work; workers in certain jobs say that this produces accidents, and they see job rotation as a solution but feel powerless to implement this. Some workers perceive that the importance of these social relations and their capacity to produce accidents would diminish if the trade union was stronger or management had different orientations.

We have seen that workers may exercise their command power to avoid working with danger, but they do this reluctantly and inconsistently. They will more easily engage in open protest against material than "nonmaterial" dangers. However, they do informally combat the latter type of danger. They have, by and large, refused to invent or adhere to systems of symbolic recompense, like intergroup competition and tallychasing, which would link their own prestige to work performance. In spite of the difficulties that emanate from the functional differentiation and separation of jobs, they have sought to forge strong interpersonal ties. This workgroup organization and general camaraderie has

resulted in a reduction in management's potential to administer work through the command level. Through informal communications with workmates, in addition to their use of formal company reporting systems, they act to reduce the weight of disorganization. Through their resort to what have been called auto-organization and autocommand, workers can be interpreted as playing a considerable role in ensuring that their accident rates remain lower than they would be if they adopted a more passive role. These same workers recognize and identify areas where changes in social relations could serve to further reduce accidents.

The direct exercise of command pressure by management was felt by workers (and was observable to this researcher) to play a definite role in the production of accidents. In interviews some supervisors admitted the importance of their use of authoritarianism. This relation was most acute when the mill breaks down. One worker clearly expressed an oft-repeated notion: "Men take risks, foremen help that along especially . . . when they panic." For this mill hand, the main situation in which related accidents arise is when shortcuts are taken to get the machines working.

What dangers do breakdowns present and how are they to be analyzed? When bits of metal unexpectedly fly off a machine and hit an operator, the accident is classified as being a result of an organizational level social relation. The relation is disorganization, in which unperceived dangers that are outside of the machine operator's area of task competence produce the accident. Should workers perceive that a machine is in a state where it might break down and in so doing be dangerous, they are faced with two alternatives: to stop or continue working. The latter will be chosen either because of authoritarianism (intimately linked with a lack of command level power to resist executing dangerous work) or because of the existence of an orientation that is favorable to working with the dangers. Such an orientation is produced at the rewards level, either through financial incentives or symbolic rewards, or at the command level through the relation of voluntary servitude. In this plant breakdowns were an important source of disorganization, and appeared to directly produce an important proportion of accidents and near-miss accidents. The vast majority of breakdowns did not result in accidents; however, some did lead management to increase command pressure on workers to encourage a return to work; this was particularly so on the mill.

But why do breakdowns occur? This plant is little different from other semimechanized or semiautomated plants in this respect, where the division of labor leads to workers being unable to obtain full knowl-

edge of the machines on which they work. In such plants important maintenance is normally carried out by specialist workers who may labor under one of two classic policies: preventive or breakdown maintenance. The former shuts down machinery and examines equipment at regular intervals to check on and renew pieces. With the latter, such operations are carried out only when the machine grinds to an unscheduled halt. In such cases the breakdown is the weak link in the production chain. The second policy dominates in this plant and thereby produces disorganization. Minor breakdowns occur with frequency and many can, in keeping with a "do-it-yourself" mentality, be repaired without the intervention of specialists. It is during such incidents that supervisory pressure to return production to normal occurs on the mill.

In the case of major breakdowns or necessary equipment changes, regulations demand that specialist fitters be summoned. These are on constant call and interviewees, both supervisors and workers, berated them for being unhelpful and working only when absolutely necessary. In their eyes, it was not poor management that was seen as responsible for inadequate (breakdown) maintenance, but rather the actions of the fitters. A classic organizational conflict of the type so insightfully described by Crozier[3] exists between production and maintenance functions. Mill and reprocessing workers are dependent on maintenance staff, who are highly skilled, not easily replaceable in the labor market, yet are essential for production; these factors confer considerable autonomy in their relationships with management. Through their ability to set the pace of breakdown repairs, fitters exert power and thereby demonstrate their indispensability to the running of the plant. The workers are sufficiently production oriented to dislike being forced to remain idle in such circumstances. However, neither they nor their supervisors can exercise muscle to bring the fitters to work. The fitters simply claim they have more important things to do and, if pressed, covertly threaten to delay their intervention even further. Impotent, the production workers and their foremen blame everything on a personality conflict between the plant manager and the foreman fitter.

The mosaic of the plant—once complex, formed by the noise, helmeted men, diverse tasks, and apparently dangerous processes and practices—now appears much simpler than on entry. The production of the majority of accidents is explained by reference to the organizational level, a smaller number by the rewards level, and even fewer by the command level. At all levels, workers hypothesized, accident production could be lowered by different types of managerial or worker intervention. To what extent is another question, one that a still-closer analysis of workplace dynamics should permit us to address.

Intershift Differences in the Production of Accidents

A number of variables remain the same between shifts and others change somewhat. Obviously, factors that structure the workplace such as process type, turnover rate, frequency of factory inspections, formal union influence, and safety committee operation have consistent effects on both shifts. However, the state of other important variables is less of a given. Night activities may be different from day; so great were the differences in one plant that proposed research was abandoned. In the pipe plant some dispatching work and the operation of the coiling machine are carried out by permanent day workers; thus, the factory is different between shifts, but this difference was not seen to have had a significant impact. Productivity, for all the discussion surrounding it, was a factor that proved unmeasured in the reprocessing part of the plant. However, a management study on the mill was widely referred to as having shown higher production on nights than on days. Explanations for this varied. Workers and some managers referred to the differences in social relations between shifts, others perceived that the simpler production runs were planned for night shifts. Observation shows that the materials employed, safety devices, and plant utilized remain the same between shifts. Significant differences are visible in the supervisory presence between shifts, the social relations of work, and accident rates.

Interviews revealed the felt effects of the increased span of control to be found at night: "things are easier here because the bosses don't stand over you." In spite of reduced supervision, production levels appear to be higher than on day shift. The workers are conscious that their relative freedom on nights confers advantages; they express greater job satisfaction with night shifts yet often lament its effects on family and social life. In order to retain this relative freedom, a collective orientation has developed in which a certain set of what might be called "autonomous worker values" are pursued in an attempt to achieve "autonomous worker objectives," such as job satisfaction, safety, and continued autonomy. Higher production levels appear to be one consequence. However, there are some further changes at night: fewer goods are transported and maintenance is more efficient. At night, "when there's a breakdown . . . the fitters help the guys." Such prompt attention to breakdowns reduces any need night supervisors might feel to pressure for the restoration of production activities.

The Organizational Level. Training aims at reducing underqualification, but it is made difficult by the constant noise of the factory. On night

shift the training officer is absent, but this is not seen to alter levels of qualification between shifts. In addition, normal, on-the-job training continues on both shifts. Workplace disorganization is, to some extent, reduced at night because less product transport activities are planned. It is possible that the positive effects of this change may to some extent be counterweighted by higher nighttime productivity, which could be expected to increase statistical probabilities of machine breakdown.

Routine tasks continue to be exercised on night shift, however, in the absence of supervisory control, and in accordance to their orientations, workers engage in informal rotation to combat monotony. This auto-organization adds to the limited formal system adopted by management on both shifts. In addition, certain machine operators could be observed reading on the job; they justified this activity as an element in the fight against the negative effects of their routine tasks. Management believes such activity results in stoppages and punishes offenders on day shift, whereas at nights what Gouldner calls "mock bureaucracy"[4] prevails.

The Command Level. A high level of cooperation between workers is required for the productive and safe execution of some tasks. Impediments to visual communication among interdependent workers engaged in the same task produced the following accident: a misunderstanding between a crane driver and his chaser resulted in the former moving the crane so that the chaser was injured. Noise added to visual communication difficulties further promotes workgroup disintegration; this relation carries slightly more weight on days where employer command pressure is perceived to perturb the normal flow of communications.

Voluntary servitude is present on both shifts; in part it relates to those features of the factory that are seen as unalterable, many of which are the product of uncorrected design errors. One mill operator, to give a relatively banal example, had strained his ankle on a metal lump that was a permanent and "normal" feature of a catwalk; subsequent to this accident, the lump was removed. The importance of this relation varies little between shifts.

The key difference between day and night appears to be the following: workers who are collectively organized and oriented by what could be called "autonomous worker values," when engaged on night shift are more willing to resort to autocommand and to refuse work and situations they define as dangerous. This occurs when workers rotate jobs to reduce routine work and, as we shall see, at the rewards level where they act to reduce the weight of extended work. Their patterns of action

change as a function of the reduced supervisory presence at nights. At the command level a reduced management team becomes more inclined to correct a dangerous situation than to resort to authoritarianism by insisting that work continue. A consequence of this change, at a general level, is that workers unanimously perceive their bosses as being nicer at nights.

Rewards Level. Night workers are able to lessen the impact of domination at the rewards level. "If everyone works together . . . [an overly tired worker] can go to sleep," as workmates cover for him. The effects of extended work, whether produced by the overtime that is worked on both shifts or by other factors, are lessened by this recourse. This is a recourse available only because of the freedom that the state of the command level on night shift confers.

The only form of rewards-for-effort that exists is symbolic and is confined to the two-person teams engaged in a part of the galvanizing process. They keep tallies in an informal intershift competition, which they justify with reference to its role in monotony relief. Their competition takes place in defiance of management rules. Between day and night no difference in behavior was observed among the participants.

Recourse to autocommand on night shift, it is important to note, must be made with attention. If the spelling of overly tired workers or task rotation augments the underqualification or the fatigue of those engaged in relief, it could raise accident rates and reduce quality and production levels. It is here that supervisory power may come back into play; if its strategy of conceding autonomy on night shift should come to be regarded as a failure, management would eventually seek to remove it.

The Individual Member Level. Interviews revealed sources of concern at this level when nighttime drug use was alleged by some workers. It was generally recognized that horseplay rose on night shift where it was seen as a viable technique of boredom relief. Fewer dangers emanating from this level were perceived on day shift because of employer command level safety management. Worker mechanisms of collective autocommand appeared to operate to ensure that this level did not take on an even greater weight at nights. In spite of acknowledged dangers, no accidents associated with the operation of this level were revealed.

Conclusion

Managers reduce their role at the command level on night shift, which, coupled with the presence of organized workers who have orien-

tations favoring their own safety, leads to an expansion of worker control on this shift. Workers are thus able to diminish the effects of disorganization, routine work, authoritarianism, and extended work on the production of accidents. In spite of a countervailing increase in the weight of the individual member level, the same workers are half as likely to be accident victims when working night shift than they are on days.

This analysis leads to a simple insight: this plant's overall lost time accident rate could be substantially reduced if the social relations used to produce work at night were employed during the day.

Extrusion Plant: Plant E, Traditional Management, Rotating Shifts

On entering this plant, one is first confronted by its grayness. Two gray presses, one near each wall, hiss, crack, and whirr; groups of men in gray overalls hover around, watching each machine's movements, controlling them or extracting their products. A yellow forklift disturbs the somber surrounds as it suddenly races to deposit a bin of raw materials, to be fed into the extrusion press. It uplifts a bin of extruded product and turns its back on the plant, its gray walls lit up with occasional safety posters.

The Technical System

Preprocessed raw materials, with different compositions and strengths, are stacked in cradles and automatically feed the presses. Constant adjustments and checking must be performed to ensure that the right materials are fed at the correct time. The materials are heated and then pressed, like toothpaste out of a tube, through a die that gives shape to them. On leaving the machine, the extruded piece is manually removed from the path of the following piece, to be subsequently inspected, reprocessed, cut to length, and reinspected in a series of machine-assisted operations. Dies are regularly replaced as production requirements for the shape of the product change, and materials are varied as requirements for strength and other properties alter.

Both presses operate in a similar manner and have similarly structured workgroups. Nine workers on night shift and ten workers on days are employed at each. A foreman supervises the operation of both presses, and on day shift, three further supervisory staff and a training foreman add to the plant numbers. In addition to their roles in managing the extrusion process, this extra daytime staff supervises a process that, because it runs only during daytime, is excluded from this study. Two

charge hands are employed on each shift to control and coordinate work on each press.

The Human Element Located in the Production Process

Semiskilled teamwork ensures that materials, pressure, speed, and heat are adjusted at the press operation stage so that the required product can be made. Two operators coordinate their efforts to ensure this. A third man, responsible for changing dies, is obliged to cooperate closely with them. At the output stage tasks require varying skill levels, are interdependent, and demand a continuous work rhythm on the part of all. One man ensures that the product is cleared out of the press, two subject it to final machining, and another cuts it to required lengths. Subsequently, the product is examined by a quality inspector (who is also excluded from this study) and, following this, stacked and classified by another worker. A forklift driver services the press and, as previously mentioned, a charge hand oversees all operations, providing assistance where necessary. At nighttime, one less worker is employed at the output stage.

Work rhythm is determined, in part, by product characteristics. Over 2,000 separate products can be made on each press. Some are manufactured at a speed that imposes demands, seen by both management and workers, as excessive. Others are manufactured slowly, leaving workers considerable spare time. The work stations near the press are hot and noisy, and signs of the most common hazard of press-related jobs can be seen on many a worker's forearm: scars caused by burns from heated parts of the press or the product. The work rhythms of those who reprocess the extruded product are largely determined by press speed, which in turn is partly dependent on the skill of press operators and setter. Production is halted whenever reprocessors are unable to keep up with the press.

The maximum training period for any job is six months, but for the vast majority of jobs it is considerably shorter. The work here belongs to type B process, where "men are held down to work of an extremely simple repetitive nature, often nothing more than machine tending."[5]

Workers demonstrate a low level of job satisfaction. This cannot be seen as a product of the task structures to which they are subjected, since pipe plant workers have relatively similar tasks yet appear much more satisfied. One conventional explanation of dissatisfaction is that the plant accumulates dissatisfied workers who, because of an unfavorable labor market situation, find themselves forced to stay there. This explanation can be discarded; the extrusion and pipe plants operate in roughly comparable labor markets, yet this plant has an annual labor

turnover rate of 71 percent, more than three times that of the pipe plant! Touraine provides a crucial insight: job satisfaction and like properties depend "entirely on aspects other than the actual task, on social aspects, that is to say on the degree of social participation of various kinds by the worker."[6]

The Social Relations of Work

The Organizational Level. "Here all is self-taught," says a worker indicating his view of the training given to workers engaged at the many tasks that have low skill requirements. In addition, the evidence points to training being inadequate even for some jobs that demand skills. Stories are told of thousands of dollars worth of scrap and of accidents being produced by insufficiently trained staff. Much of the training is carried out on the job and interviews consistently revealed that recent recruits are inadequately instructed. In the words of a new employee, "older workers expect the newcomers to know everything; it happened to me on the saw." Although formal company rules exist to ensure adequate training, these are not adhered to by plant management.

Several parts of the production system are poorly designed and hazardous conditions are a consequence. These are often rectified only after accidents occur. "I got my foot crushed and then they changed the system." The workers exert no collective pressure at the command level, which is capable of persuading management to lessen the role of disorganization. Supervisors, engaging in organizational level safety management, sometimes issue individual protective equipment to prevent accidents associated with what are seen as specific technical hazards; in terms of the sociological analysis, these hazards—burns, cuts, and eye injuries—are produced by disorganization or voluntary servitude. However, this equipment has become a source of conflict: supply is sometimes poorly organized and certain workers refuse to use it.

The plant is, in comparison with the pipe plant, well coordinated: production is planned, maintenance carried out on a preventive basis, and material transport is structured in such a way as to not cause risks to nearby workers. Disorganization due to poor maintenance has little weight compared with its counterpart plant.

Production runs are short and change frequently, which introduces variety into the many jobs that demand limited skills, and through this results in the general absence of routine work.

The Command Level. The production process is organized in such a manner that a high degree of integration within each team is a functional imperative. In the eyes of the men, however, there's "no team here," or,

in a positive evaluation, "the fellahs are good but I've been in better teams before." Certain difficulties of workgroup communication were related in interviews. A search of records implicated this relation in the production of nonlost time accidents, especially when linked to language difficulties between members of multiracial teams. More importantly than the language barrier, however, the restricted development of workgroups appears to be inextricably linked with the weak (almost nonexistent) trade union structure and to the authoritarian management style practiced. One consequence is that job-related difficulties, of a nature that would incite questioning and discussion by workers in most other plants researched, are not dealt with here.

A senior worker commented that the relationship existing between management, safety, and worker command power in the following terms: there are "lots of things we shouldn't do and once you go and see the union you're down the road." Managerial strategy decimates any worker pretensions to enduring autonomy at the command level, and as a result "all the men are weak and gutless." Authoritarianism becomes clearly visible when one notes that interviewees refer to the question of dismissal more than in any of the six other plants studied. When they discuss the workplace, interviewees demonstrate fear of certain elements of their job and express an incapacity to do anything about them. Authoritarianism is employed to produce both extrusions and dangerous work.

Relationships to a good number of hazards were managed through voluntary servitude; hazards were handled as though they were a natural component of the workplace. In particular, as already mentioned, relationships to many of those hazards that led to frequent burns inflicted by the press and product were managed in this manner.

The Rewards Level. At the rewards level both production and quality are related to bonus payments. Workers have a favorable orientation to the financial inducements system and in addition have complemented it through the development of intershift competition for production tallies. "Shifts work against each other, we lose faith in ourselves because we lose all the time, all gangs encourage it."

The bonus system is far more complicated than it might at first seem. It combines the payments earned on each press and then shares them between shifts. From a sociological viewpoint, the effect of a bonus is dependent on its social insertion; in other words, on how the perceptions of its operation influence orientations and how these transform into action. The bonus combines complex indices of quality, quantity, and type of production. Through interviews it was revealed that no one,

including supervisory staff, understood its operation clearly. I do not wish to belabor the point that I was not the only person to perceive the bonus system as both bizarre and perplexing. It is in the gap created by this complexity that intershift tally competition comes into its own. It provides a palpable measure by which workers link effort to rewards; this link is a subjective one without any predictable relationship to payments received. Faced with pay envelopes that do not bear clear relationships to either production tallies or levels of recorded quality rejects, the workers request a comprehensible bonus system. In the meantime they are oriented toward achieving high production levels as if this were the only criterion of value. Interviews revealed that the bonus underlies the resort to tallies, and that workers work harder than they would in the absence of a bonus. "We take shortcuts . . . [this means] rejects. We [supervisory staff] know some jobs are too hard to do to earn a bonus and some people work unsafely to do it."

Extended work is generally acknowledged in interviews to be an accident-producing social relation. However, as the length of the average working day had recently been reduced from 10 to 8 hours, workers now consider this issue irrelevant to the production of their accidents.

Symbolic recompense, with the notable exception of the tallies which are intertwined with the bonus system, does not play any further role in the management of this plant.

The Individual Member Level. Foremen made constant reference to this level in interviews and many workers made their first analyses of accident causes in terms of it. In spite of this, its weight in producing accidents appears minimal when examined in isolation. If we look at its relationship with other levels, the picture changes somewhat; for example, production demands are seen as excessive and led some to resist through sabotage: "winding up the die" to block its action is one technique. This type of action, seen as "stupid" by some, is produced both at the individual member level and in opposition to defined work relations, and has the potential to produce accidents.

Day and Night Differences

The Organizational Level. Night work is accompanied by an increase in the weight of underqualification. This occurs in the following manner: fewer workers are employed at nights than on days; there is no managerial policy to ensure full staffing of each press; this combination of factors leads to absent workers being covered by moving someone else into the vacant position; the next person down is then "bumped up"

the job hierarchy to fill in, and so on until the lowest priority tasks are left unstaffed. With the high labor turnover and type of training given, a situation is produced where, in the words of one foreman, "Too many know one job," a factor he sees as producing its own dangers in specific situations: "danger creeps in with short manning." Interpreted sociologically, the mode of managing the job in situations of short staffing increases the weight of underqualification.

The weights of routine and disorganization do not appear to alter between shifts, and their role in accident production remains the same.

The Command Level. Considerable alterations occur at this level. Fewer supervisors are found on night shift, and one visible consequence of this is that less safety gear is worn. "We usually strip to the waist [because of the heat]. We only do it on nights . . . when there's no bosses around." The ever-present dangers of the job are increased by the actions of the men on night shift, and the importance of voluntary servitude rises considerably. Workers see safety gear as symbolizing "the bosses' " domination and as forced upon them on day shift. Without this "symbol" they can work faster and more comfortably. The potential effects of this action on individual safety are considered irrelevant by the workers; they voluntarily accept whatever increased risks they run as a natural consequence of their striving for greater immediate comfort.

There is no visible change in workgroup integration between shifts. This observation is, for me, a surprising one given my expectation that changes in supervision would be associated with a spontaneous modification of workgroup dynamics.

The reduction in supervision experienced at night is viewed positively by some workers. It is worth noting, however, that the proportion of interviewees with this belief is small compared with the pipe plant. "I prefer night to days, no one is pushing you around, half the fellahs on days panic because there's too many bosses." A possible explanation for a relatively small number holding this view is that the majority find themselves working harder on night shift; this phenomenon is to be understood by reference to the rewards level.

The Rewards Level. Formal financial incentives function in the same manner on both shifts and the same number of hours are worked; what is observed, however, is that rewards level social relations translate differently between shifts.

No liberty is conferred on the overly tired worker, permitting him to rest on the job. Supervisors do not openly recognize that abilities may be

reduced as a result of fatigue, and no informal system exists among workers to counteract the social relation of extended work. Tiredness is more common on night shift and, according to interviewees, especially toward its end. The interview material leads to the preliminary conclusion that the weight of the associated relation rises on nights. However, I was unable to locate causal data on accidents to validate this hypothesis.

The bonus system is not, at an initial stage in interviews, perceived by the men to account for the important observed differences between shifts. They have come to see risk taking as a legitimate method by which to achieve production totals. This orientation is produced by a combination of the financial incentives offered and the quest for symbolic rewards. These two relations are inextricably mixed in this plant, and workers normally began interviews denying their role in producing accidents. When questioned about specific incidents or asked to explain specific actions, however, they presented meaningfully adequate explanations on the role of these relations in producing dangerous work.

Because lower manning levels operate on the night shift, average production totals are obtainable only with relatively increased physical effort. In spite of this, management reports that such totals are more frequently obtained on this shift, albeit with certain quality problems. A charge hand commented, "We're supposed to have full gangs, we've always worked short, a full gang is nine, we run it on six, that's when danger creeps in, I'd rather work with a full gang and properly than dangerously to get a bonus."

"At night a bad run is really bad," for the short-staffed workers. Yet management realizes that they "jump standard procedures on nights . . . [the] job gets done faster, we all know it happens, [there is] nothing wrong with it really." On night shift, workers are observed carrying out a multitude of "dangerous acts" that they were not seen to perform on days. They are motivated by bonus payments or production tallies, and their action is facilitated by the absence of a daytime constraint: "we take shortcuts on night shift 'coz there's no bosses."

Not all of the rise in productivity levels can be attributed to the influence of rewards level social relations at nights; some of it is due to the fact that time-consuming experimental runs and some routine maintenance are carried out on days. Product quality drops because certain control procedures that give feedback and permit immediate corrective action are absent at night. Because of management's staffing policy, nocturnal absenteeism leads to greater underqualification. The motivation to achieve higher production totals under such adverse circumstances results in work frequently being carried out at excessive speed.

This can be seen in the mens' actions: they jump over tables, handle overly hot materials, and the die changer exaggerates speed on the block and tackle; actions such as these appear responsible for a part of the rise in night shift accidents.

Individual Member Level. The weight of this level is seen to rise somewhat on nights. The men use personal safety gear less frequently, but the linkage of this to accidents proved an unconfirmed one. From an analytical viewpoint, the individual member level assumes its full weight when the line is crossed that separates rejection of safety gear as a symbol of social domination (i.e., a refusal couched in terms of social relations) from its rejection as an act of individualistic self-expression.

Conclusion

The combination of changes at the rewards, command, and organizational levels allows for a clear explanation of observed differences in intershift accident rates. The observations of work performance and interviews clearly indicate that the autonomy permitted at nights penetrates into work relations in such a way as to increase the weight of social relations associated with the operation of voluntary servitude, financial incentives, and symbolic recompense in the production of accidents. In addition, underqualification assumes an increased role and there are unconfirmed notions that extended work and the individual member level also make their contribution. The rise in night accident rates relative to daytime bears startling testimony to the importance of these changes.

It seems safe to conclude that a different set of worker orientations or of management policies in relation to nightwork would have produced a different set of outcomes.

Comparison of the Pipe and Extrusion Plants

Industrial accidents are produced quite differently in these two plants, and this occurs in spite of the relative similarity of the production processes, required levels of staff qualifications, and local labor markets. Underqualification shows itself to be a more important social relation in manufacturing extrusions than in pipe making. Disorganization due to poor maintenance and design and routine work appear more important in the latter.

The differences between the plants become quite striking once one examines the command level's functioning. The pipe plant can be said to

contain certain general characteristics: foremen are close to their men, management is generally considered nonauthoritarian, workers form cohesive, integrated groups, and the trade union is strong. In the extrusion plant union activism suffers repression, workgroups are not integrated, and configurations of similarly hazardous conditions and practices that are questioned in the pipe plant are left unquestioned in the extrusion plant. For these reasons, voluntary servitude, authoritarianism, and workgroup disintegration have comparatively greater weight in the management of work in the extrusion plant.

Differences registered at the rewards level prove important. Bonus payments offered in the extrusion plant meet with a favorable orientation and lead men to work unsafely; added to this are the orientations to win interteam competitions. Risk taking is legitimated by the workers. On day shift, however, because management resorts to command level safety management, dangerous actions produced by this orientation are reduced. Pipe plant workers are not subject to incentive payments and the influence of the relation of symbolic rewards is almost nonexistent. In contrast to their extrusion colleagues, they exhibit strong orientations that translate into command level actions to contest job dangers. These orientations flow, in an important manner, into autorewards where workers seek to reduce the weight of extended work by covering for tired companions in need of repose.

The key variation brought about by shift work is that, regardless of the management style in use, managerial control is relaxed at nights. This relaxation results in certain concrete changes in workers' actions: in the extrusion plant this leads to the production of more accidents and in the pipe plant fewer.

As a result of these field studies, two major issues arise: first, the interplant comparisons prompt one to ask why each plant does not adopt those social relations found to correspond in the other with low accident production? For example, pipe plant workers have recently had their risks of accidents because of underqualification reduced and in the extrusion plant disorganization is not a problem; what is to stop one plant learning from the other? The second question asks why plants do not learn from their own experience? If the pipe plant were to do this, it would swap daytime social relations for nighttime ones, thus reducing its overall accident rate.

Interlude: Reflections on the Sociology of Accidents

Questions such as the previous ones cannot be satisfactorily answered if we assume, as does much safety management literature, that

the primary objective of firms is the reduction of accidents. In the pipe plant we saw that training was linked to a decline in those accidents due to underqualification. However, safety professionals use examples of such successes to develop an unwarranted complacency about the value of their actions. In interviews they were invited to reflect upon questions such as those raised, and in reply their incapacity to act was frequently blamed on deficient managerial support and external constraints on their firms' operations. Such replies, which are political and economic in essence, are often relevant in explaining elements of safety managements' incapacity to act. However, they are entirely irrelevant with regard to the specific questions examined here.

Here, safety managements' failure can be better analyzed as a product of its worldview. This posits that safety is an act of pure reason; that given a world free from constraints, it can be engineered; and that, through standardized interventions and procedures in both the material and human areas, safety management is the carrier of this reason. Safety management thus counterposes itself to the irrationality of workers, to political forces within the firm, and to economic forces outside the firm, and these factors are seen as combining to limit its capacity to develop successful action. Such a worldview is opposed to one in which safety is seen to be created through conflict and consensus of opposing actors in a workplace, one in which safety is to be perceived of and managed socially, and where social actors, in accordance with their notions of truth and justice, have a fundamental role to play in analyzing the production and prevention of their own accidents.

One of the interests of a sociological approach is to provide a theoretical path out of the impasse in which safety professionalism, in postrupture years, finds itself. These two case studies provide some very practical reasons for safety professionals to think along new lines, since such thinking challenges the very basis of their worldviews. In an effort to provide further insights, and particularly to suggest new paths of research, one further field study shall be presented before proceeding to a general examination using statistical tests of the seven plants researched.

The Yarn Plant: Plant F, Induced Management, Fixed Shifts

The first impression one gets on arriving in this plant is provided by the rows of brightly painted and droning machines. The plants previously visited seem so dirty and gray in comparison. A worker greets me with his impression, "it's noisy here, things flying around and up and down . . . [there's] probably a type of hypnotism here."

The Production Process

Three different processes operate: first, five carding machines transform fiber from its raw state into a reprocessable one. The product of this is loaded onto 1 of 14 spinning frames and then fed into the frame to be automatically spun onto 50 separate spools. The once-spun product is then loaded onto one of a set of seven frames to be respun. In the third process, this twice-spun thread is rewound on one of six machines to be transformed into hanks of salable yarn.

Raw product flows in one end of the plant and finished product out the other. All production activity, except carding, is carried out by people at individually assigned jobs. In the carding section each worker is given responsibility for a single machine, but in order for the process to run smoothly, these operators help each other in a team effort.

A small number of charge hands and service workers, the latter including both skilled repairmen and unskilled laborers, attend to the needs of all machine operators. No machine-operating job is officially judged to require more than three weeks training. Each spinner is required to work on two conventional or one respin frame. Twelve months experience is generally considered necessary to become a proficient spinner, one capable of loading the machine, supervising the mechanical fabrication of all types of thread, correcting all the faults as they are produced, and unloading the frame. Whenever the shift is short staffed, frames lie idle or, on rare occasions, overtime is worked by members of other shifts.

In hanking, physical effort plays the most important role in determining performance. The bobbined thread is semiautomatically wound onto spools and taken off them to be transformed into hanks. Each hanker is responsible for one machine, and the machine's role in determining work speed is very limited. The loading of thread and the unloading of hanks constitute the major tasks of the workers, and the rhythm of task accomplishment is determined by their speed at these tasks.

With carding, raw material is fed into large and complex machines. The workers' job is to control input and to operate the machine to ensure that its vicious-looking combs clean and stretch the raw fiber to make it into a spinnable product. Different machines may receive distinctly classified input thereby producing different grades of output. At the feeding stage, and when problems occur in processing, the efforts of all team members may be required to guarantee production by just one machine, the others being left to run unmanned. In this manner, problems are rectified promptly and better production totals are produced than would be obtained with purely individual efforts.

As in the two plants previously examined, and as in the other fixed-shift plant investigated, the major production tasks can be characterized as belonging to type B process.

Social Relations of Work

The Organizational Level. The majority of tasks require little training and the work force considers itself to be adequately qualified. This opinion is supported through a perusal of accident report forms, which indicate underqualification as a producer of accidents only on rare occasions. The most common type of underqualification is that produced when a machine requires adjustment or breaks down; in such circumstances, plant regulations stipulate that assistance be sought outside one's workgroup. A certain degree of what Gouldner called "mock bureaucracy"[7] can be found, in which a series of rules are frequently defied as workers are motivated to repair their own machines illegally, and the training given is inadequate to ensure safe performance of such tasks. "Keys exist to block access [to some parts of machines], but this is unrealistic because of job pressures" stated one worker. In the words of another: "the two weeks [the normal training period for his job] trains you for the formal requirements of the job and not the things you have to do to make a bonus [and] which everyone does. . . . [they] should train every operator so's he knows what to do with the machine."

General maintenance, housekeeping, lighting, and like elements of work organization that are the responsibility of nonproduction workers are generally of a high standard. Tasks are not interdependent to the extent that difficulties in relationships between them may produce more than rare accidents attributable to disorganization.

Many tasks, specialized and repetitive in their conception and execution, are considered to be monotonous. "If everything's running well it [spinning] can be monotonous." A foreman reflects that the relation of routine can produce accidents, "a person here a long time can become complacent, a lot of older workers lose interest." In order to avoid this risk, foremen take preventive measures, for example, they "rotate spinners among frames."

The Command Level. The majority of workers are engaged in spinning or hanking and these activities physically isolated them from their colleagues; in spite of this, a strong spirit of unity and relatively good interpersonal relationships can be found. Noise, however, hampers functional communications in some situations and a crude form of sign language is used to overcome this.

"If the union brings safety to management's notice it's acted on

right away." The men see their union as strong one. As evidence, they state that the major part of their demands are met without resort to industrial action. Management, having in the past lost some conflicts, respects the union, seeks out negotiated solutions to conflict, and does not try to undermine its role. There is no hint of the existence of an authoritarian management style capable of provoking risk taking.

Some hazards, in spite of all that has been said about union and worker strength, are known and worked with by operators. Generally they originate because of design difficulties and are not questioned in a serious manner, but rather are accepted as a regular feature of the job; voluntary servitude is used to manage relationships with such risks. The safety committee, seen as immobile, contributes to this state because it acts as organizational padding, absorbing worker complaints about some recognized hazards and thereby protecting the company from perhaps costly action. In addition, "the company has a lot of written standards which, when it costs a few dollars to rectify, are not enforced." Change in conditions that are known to be unsafe is seen to come about mainly after accidents occur: "tin plate was put on the rollers [of a carding machine] after two guys got their thumbs chopped off."

The Rewards Level. A bonus payment system exists for all production workers. For carders this is calculated on a team basis and for remaining production staff on an individual basis. According to a supervisor, "a lot of accidents come in with chasing the bonus, to my mind it's the most necessary evil in the place, we couldn't do without it, [it] gets them back on the machine after smoko break . . . people take risks to get it, [this happens] more with new personnel racing to get a bonus, we have older people who don't chase the bonus any more, then [their] production is slower." However, the bonus system is less subject to conflict than in other factories researched; it is "not a gut-splitting bonus" and workers do not express fear that any significant rise in earnings will be met by management rate cutting.

Overtime is relatively uncommon, being worked only when there are pressing production needs. Absenteeism is managed by shutting down missing personnel's machines. Therefore, extended work produced solely within the plant constitutes a relatively uncommon relation and appears, along with symbolic rewards, to be potentially associated with minimal accident production.

Day and Night Variations

The work forces to be found in the plant differ between day and night. The night workers are younger, and have accumulated an average

of 6.9 years' service compared with 12.6 years among the day workers. The workplace appears busier on day shift when 39 workers and 5 supervisory staff can be found, and in spite of this number being 50 percent greater than the 26 men and 2 supervisors to be found at nights, the plant does not appear overcrowded. Work patterns for carders and hankers do not appear to vary between shifts. Spinners, instead of cooperating in the loading and unloading of the frames, work in relative isolation from one another at daytime.

A plant survey showed that there was no a priori link between the average length of service of workers on a given shift and shift productivity. There is, however, a correlation between length of service and accidents. The average worker on the three shifts worked in the plant has been in the company's employ for eight years and the average accident victim for only four years.

Changes at the Organizational Level. The degree of work force qualification remains the same on both shifts. This occurs for two reasons: first, for all shifts the company has a well run training program. Second, the machines of absent staff are usually closed down for that shift; thus, recourse to overtime work or underqualified staff is avoided. Staff transfer that does occur involves the moving of adequately trained hankers to spinning.

Disorganization associated with factors such as the state of housekeeping and interference from other groups is, if anything, reduced on night shift due simply to the reduction in worker numbers. Maintenance is not of the same standard on both shifts, and night workers expose themselves to risk by readjusting their machines. Such action, which raises the degree of underqualification, is performed because of rewards level social relations.

Spinning and hanking are essentially routine tasks. Spinning is "boring only when perfect" and for the workers this perfection is not an uncommon state. "I've seen people actually sleep standing here" said one as he depicted an image of spinners on "good days." Workers suggested that the combination of the unique type of monotony produced by the spinning frame and the fatigue that is specific to night work could interact to raise the production of accidents due to routine work on this shift. This hypothesized relationship was unverifiable given the resources and the methods used in this study.

Overall, the organizational level is tentatively judged to carry slightly more weight on night shift.

The Individual Member Level and Changes Therein. This level is not observed to have any role in the production of different patterns of

accident causation. The question of alcohol consumption by night staff prior to the shift was touched on, but management suggested that their watchful eye prevented this becoming a factor for concern. A slightly greater weight can be attributed to this level at nights.

Changes at the Command Level. A permanent night worker who occasionally performed overtime expressed his feelings about day work: "[you are] very careful about what you do because of supervisors." In other words, command level safety management is reduced on night shift. "If a foreman watches you, you won't make any money . . . if you want to make money you work this way."

At nights, spinners were observed to cooperate more than their day shift counterparts. This change, which led to the need for greater work-group integration, was not observed to have any negative effects on safety. Through interviews one learns that extreme forms of workgroup disintegration had previously been a feature of the plant; for example, fights occurred among individuals eager to guarantee the best materials for earning a bonus.

Voluntary servitude appears to have a consistent weight between shifts.

Changes at the Rewards Level. The principal change between shifts occurs at the rewards level: work intensifies on some jobs at night leading to increases in productivity, increased bonus payments for individuals, and to more accidents. An older worker who had transferred to day shift reflected that the "bonus makes people work harder, especially young people, we used to go flat stick to get a bonus." In common with other older workers he claims to have now given up "gut-busting," the material needs that drove him in his youth having now been satisfied. A night foreman uses a language different from that of his daytime counterparts in referring to the use of command level safety management to control workers' actions: "if I don't watch jokers'll [workers] get carried away for a bonus."

An analysis of accident records, backed up by interviews, leads to the conclusion that the bonus is a cause of more than twice as many night as day accidents. Overall, day and night productivity rates (measured by aggregating the number of kilograms processed per machine hour) are exactly the same. However, there are strong differences between tasks. Night productivity is 18 percent higher for spinning, 1 percent higher for respinning, and 6 percent higher for carding. Hanking suffers a dramatic decline of 19 percent. Carders engage in illegal dangerous practices to keep their machines turning: going under the moving machine to remove obstructions is a practice that has eaten

fingers and, when sticks are used, has resulted in breakdowns costing thousands of dollars. Foremen see their own presence as indispensable to avoid such action, but with less supervision at nights, mandatory procedures are more frequently ignored. Night spinners cooperate to ensure that bonuses, even though calculated on an individual basis, are maximized. Maximization of productivity is achieved by keeping the machines running at full capacity—repairing breaks in thread and replacing spools in the shortest time possible. Beyond skill, effort appears as a key ingredient in determining production levels and bonus payments. Putting their fingers into moving machinery, straining to replace spools rapidly, tripping as they race from spool to spool and frame to frame, spinners suffer accidents in consequence of this haste, and at night display a greater orientation to work in this manner. With hankers the ingredient that makes up the productivity of this routine task is neither effort nor exposure to danger, but skill; with less skill and working harder than their daytime counterparts, night hankers can be seen as exposing themselves to greater risks and, in spite of this, are less productive than their day colleagues. This lengthy discussion has been included because it provides a practical example, related to the discussion in Chapter 3, of how bonuses, as a function of task structure and requirements, can translate into the workplace in quite different ways among workers with similar orientations.

Neither extended work nor symbolic rewards appear to have much effect on either shift. Tired workers cannot easily rest because their bonus payments are directly reduced by such actions. One worker, making reference to the meal break, confesses, "I usually try to nap down for a half hour." As a certain intimacy is created during interviews, one learns about a taboo subject: the possible accumulation of fatigue by workers whose regular daytime activities (in particular other jobs) render them less capable of meeting the demands for fully fit and alert staff on the night shift. A cautious, tentative judgment was reached on the basis of the data obtained that any increased weight of extended work was not a significant factor in accounting for the nocturnal increase in accident rates.

Conclusion

The financial incentives system leads to the performance of dangerous work, particularly on night shift; it thereby creates the single most important accident-producing social relation in this plant. The relation of voluntary servitude, which manifests itself in the spontaneous acceptance of known risks, appears as the second major producer.

Command level safety management lessens on night shift, and the younger workers on it act in accordance with their orientations to increase their bonus payments. As a result, they experience more accidents than their day shift counterparts. The differential rates, however, cannot be explained only with reference to this change. The possibility was raised that the nature of routine work during spinning alters on night shift, but within the constraints of this study I was unable to test the validity of this notion. An additional unconfirmed (and tentatively rejected) hypothesis was developed on the basis of interview data that the relation of extended work increases the weight of this level.

These findings are by far the least conclusive of those for any of the seven plants studied. Such a result reinforces the need to refine methods and for sociological theory and research to receive technical support from various disciplines active in the field of accident research. This point shall be returned to at the end of this chapter.

FROM QUALITATIVE ANALYSIS TO STATISTICAL TESTS

Introduction

In these three case studies, the first general hypothesis—that social relations of work produce industrial accidents—showed itself to be useful for the analysis and explanation of differential accident rates. The second hypothesis—the greater the weight of a level of social relations in the management of workers' relationships to the dangers of their jobs, the greater the proportion of accidents produced at that level—was confirmed in a general and qualitative fashion. Such a conclusion, however, is underlain by a caveat: the nature of the study, the small size of the plants examined, and the limited number of accidents researched unfortunately impeded a more precise and in-depth investigation of this hypothesis.

Before moving toward the statistical tests, let us very briefly summarize the qualitative findings from the other four plants researched. I do not intend to go into a lengthy summary of the state of these since they have been reported elsewhere. Suffice it to say that in plants A, B, and C, the changes in patterns of social relations between shifts roughly resembled each other, and in discussing the pipe plant one of these was described. In plants D and E, the changes in patterns of social relations between shifts were similar, and the extrusion plant presented an image of them.

Plants F and G, in spite of being subject to the same management

style, experienced quite different patterns of social relations between shifts. This can be hypothesized as being linked to the fact that fixed shifts are worked in these plants and staff displays different orientations and capacities when confronted with similar changes in managerial control of social relations. We have seen this illustrated for plant F, the yarns plant, so let us briefly turn our attention to plant G.

In spite of a greater managerial presence and action at the command level, plant G day workers take greater risks because they are more favorably oriented toward the bonus system than their night counterparts. This occurs in spite of the relatively strong safety consciousness found on both shifts, which translates into autorewards and safer work performance only at night. At the organizational level routine appears to increase on days; this occurs because the workers are more accustomed to their tasks than are their less senior nighttime counterparts. In addition, the promotion system operates to place the longer-serving workers in the most skilled and heaviest jobs. The traditions of the textile industry brought from England are such that this promotion structure is accepted and defended by workers and unions. An articulation between the command (voluntary servitude surrounds such work) and individual member levels is produced that results in a consistent repetition of one specific type of accident: numerous back injuries occur to the most skilled workers on day shift. At nights those performing the same task are, on average, younger and back injuries less common.

It is to the statistical testing of the third and fourth hypotheses delineated at the end of Chapter 4 that we now turn. In this testing process, hypotheses that relate to conventional perspectives on safety will also be examined. Aspects of an interplant diversity that neither the detailed analysis of the three plants nor the short discussion on the remaining four have been capable of depicting are included in Table 5.2. Let us now examine a revised treatment of the statistical tests as carried out by Raftery and originally presented by Dwyer and Raftery.[8]

Testing Sociological and Conventional Hypotheses Statistically

Data

Table 5–1 compares the accident rates for each plant. The variables that appear in the final model are shown in Table 5–3.

The 31 variables in Table 5–2 and two variables derived to permit the testing of sociological hypotheses relating to autocontrol and managerial safety management were subjected to a modeling process. In order that subsequent discussion might concentrate on the modeling process itself, let us here introduce the variables that appear in the final model.

Table 5–3
Variables Used in Final Statistical Models

Plant	Shift	Total shifts	Shifts w/accidents	Accident rate	Danger level x_1	Employee control x_2	Organizational/ rewards levels x_3	Command level x_4	x_5	x_6
A	Day	20,402	21	103	7	2	2	2	0	0
	Night	18,629	14	75	7	1	1	1	1	0
B	Day	23,237	10	43	3	2	2	2	0	0
	Night	18,134	6	33	3	1	1	1	1	0
C	Day	15,836	10	63	5	2	2	2	0	0
	Night	13,197	4	30	5	1	1	1	1	0
D	Day	2,915	3	103	6	2	1	2	0	0
	Night	2,098	4	191	6	2	2	1	0	1
E	Day	7,717	2	26	4	2	1	2	0	0
	Night	4,790	3	63	4	2	2	1	0	1
F	Day	28,232	9	32	1	1	1	2	0	0
	Night	18,821	14	74	1	2	2	1	0	1
G	Day	47,641	19	40	2	2	2	2	0	0
	Night	38,247	6	16	2	1	1	1	1	0

Note: Shifts w/accidents = number of person shifts with at least one accident. Accident rate = number of accidents per 100,000 person shifts. Other variables described in text.

Variable x_1. In Table 5–3 variable 16 from Table 5.2—danger of materials—is the first to appear, and is renamed x_1. The physical danger of the plant (variable 15) was also assessed, but it was highly correlated with x_1 and thus contributed little additional predictive power; the same was true of the number of safety devices (variable 17). Thus, here x_1 is taken as a general measure of the intrinsic danger of work, or overall "danger level."

This can be interpreted in sociological terms by recalling some of the early discussion in Chapter 3. A "danger level" is a product of the assembly of transformed social relations within each plant and of certain limits that these impose in practice on capacities to reduce dangers within the plant. Danger levels vary for purely social reasons; thus, nuclear power generation, which treats some of the most intrinsically dangerous materials on earth, is safer for workers than is coal mining. If the supposedly "rational" criteria of cost-benefit analysts were to prevail and astronauts lives attributed the same value as those of miners or the test pilots portrayed in the film *The Right Stuff*, space travel might be a far cheaper and more dangerous affair than it is today. Thus, here, as in the early chapters of the book, "danger levels" in the seven plants examined are to be seen as complex sociohistorical products.

Variable x_2. The third general hypothesis was: the greater the degree of autocontrol by workers at a level, the lower the proportion of accidents at the level the worker action seeks to control. Empirically, what was seen to occur in plants A, B, C, and G was the following: where employers exert relatively less control at the command level, this left space in which employees exerted greater relative control over their own work and their own safety. This occurs because they resort to autocommand, which rearticulates into both autorewards and auto-organization; it thereby reduces the relative weight of social relations at all three levels in managing their relationships to the dangers of their jobs. In plant F (the yarns plant), day workers did not engage in autocommand yet resorted to autorewards, and through this reduced the weight of this level. Variable 26, employee control, was constructed using the data made available through the study, as an operationalization of the hypothesis under discussion. It depicts the extent to which workers control their own work relations in terms of an orientation whereby they seek to reduce accidents. In the model it is renamed x_2.

Variable x_3. The weights of the organizational and rewards levels are shown in Table 5–2 as variables 28 and 30. As they happen to covary in each plant and shift, their effects cannot be isolated and for this reason they are classed together and renamed x_3.

Variable x_4. The weight of the command level was depicted as variable 29; this was high on the day shifts and low on the night shifts represented by variable 1 so that a distinction cannot be made between command level and time-of-day effects. The command level has been recoded as x_4.

The fact that a nonsocial and a social variable covary is not a problem, because, unlike hypotheses derived from most structural approaches, the hypotheses formulated here do not predict that x_2, x_3, and x_4 affect accident rates independently.

Variable x_5: Quantifying the Third Hypothesis. This is a general hypothesis that, like the fourth one, must be adapted in view of the specific limitations and configurations of this study.

Consistent with the theory, it can be stated in the following form: in a given plant, if the weight of the command level decreases, the best predictor of what will happen at all other levels (other than the individual member level) is employee control, x_2. If this is high and is associated with a lowering in the weight of the rewards and organizational levels, a reduction in accident rates will follow. A variable x_5 has been built to allow this hypothesis about autocontrol to be tested. This is quantified by defining the independent variable as follows:

$$x_5 = \begin{cases} 1 & \text{if } x_2 = 1,\ x_3 = 1, \text{ and } x_4 = 1 \\ 0 & \text{otherwise} \end{cases}$$

Variable x_6: Quantifying the Fourth Hypothesis. This hypothesis states that the greater the degree of managerial safety management at a level of social relations, the lower the proportion of accidents produced at the level the management action seeks to control.

In these plants such management effort appears indistinguishable from the weight of the command level as measured by x_4. It could therefore be hypothesized that when this is high, the weight of the organizational level, the rewards level, or both will be lower in relative terms and this will result in lower accident rates. Perusing Tables 5–1 and 5–3, it can be seen that the evidence does not support this hypothesis. This could lead to a preliminary interpretation that safety management, as defined in terms of the sociological theory, does not have any general effect of lowering accident rates once a given "danger level" has been established in a plant. However, such a verdict is a bit too hasty.

The plant studies show that management acts in contradictory manners. It can be found using the command level (e.g., au-

thoritarianism) to ensure production and, as a consequence, accidents occur. However, management also engages in strategies to control certain worker actions that it considers dangerous. Workers perceive the first set of managerial actions negatively and the second in terms that range from approval to disapproval.

The extrusion plant (plant E) provided an empirical case where both managerial safety management and autocontrol were absent on night shift, and a sharp rise in accidents was observed. This rise was explained in terms of the increased weight of social relations at the rewards and organizational levels. The extrusion plant study thus forces new reflection on the hypothesized effects of what is called managerial safety management. It leads to the following reflection: where workers are not oriented to exercise employee control, even though free to do so, it can be hypothesized that managerial safety management has an effective role to play in accident reduction.

This hypothesis can be quantified through taking the following considerations into account: in a given plant, if managerial safety management, x_4, increases, the best predictor of what will happen at other levels, except the individual member level, is employee control, x_2. If x_2 is low, that is, if workers do not act to reduce their exposure to danger, managerial safety management can be expected to act to reduce the weight of the rewards and/or organizational levels, x_3. If the overall weight of these levels drops to a greater extent than the rise produced in the weight of the command level, the accident rate is predicted to fall. A variable, x_6, has been generated to allow this hypothesis about managerial safety management to be tested. It is defined as follows:

$$x_6 = \begin{cases} 1 & \text{if } x_2 = 2,\ x_3 = 2, \text{ and } x_4 = 1 \\ 0 & \text{otherwise} \end{cases}$$

Statistical Modeling

This modeling is designed both to test the theory through variables x_5 and x_6, which provide intershift comparisons, and also the relative explanatory power of competing hypotheses, most of which can claim to explain only variation between plants and not differences between shifts. This analysis treats variables that are calculated for intershift purposes as absolute measures and it will be later argued that the conclusions this yields from the data are valid.

On a given shift in a given plant, let the probability of an accident be p. Then the model is the logistic regression model of Cox,[9] which is:

$$\log\left[\frac{p}{1-p}\right] = \beta_0 + \sum_{i=1}^{m} \beta_i x_1$$

where $x_1, \ldots, x_m$ are independent variables and $\beta_0, \ldots, \beta_m$ are unknown parameters that have to be estimated from the data. The method of maximum likelihood, which is implemented in the GLIM computer program, is the best way for doing this.[10] Also yielded through this are tests via the sampling distribution of the deviance of the fitted model. The deviance is a generalization of the residual sum of squares in linear regression.

A stepwise approach to choosing the independent variables is used. To select the first independent variable for inclusion in the model, each of the 33 candidate independent variables is individually fitted to the model, and the one that most reduces the deviance is chosen, provided that the reduction is significant. Danger of materials, x_1, is the variable that fits best, reducing the deviance by 41 percent for one degree of freedom (the percentage reduction in deviance is a generalization of the regression coefficient, R^2).

The model is then fitted with each of the remaining 32 variables, together with x_1, in order to choose the second independent variable for inclusion; the variable that reduces deviance the most from that left by x_1 alone is chosen. Variable x_6 reduces deviance the most followed closely by x_5. Deviance is reduced by half by variable x_6, to about 30 percent of its original value. Because x_5 and x_6 are complementary variables from the same theory, x_5 is next included; it, too, is associated with a significant reduction in deviance.

No other combination of two or three of the 33 possible independent variables fits as well as the resulting model (provided that x_1 is included and that if x_6 is included so is x_5). The power of the sociological explanation is revealed it its generalized R^2 of 0.85. Table 5–4 summa-

Table 5–4
Model-fitting Results

Model	Deviance	Degrees of freedom	Percent of deviance explained (R^2)
All plants same	38.5	13	0
x_1	22.6	12	41
$x_1 + x_6$	11.4	11	70
$x_1 + x_6 + x_5$	5.6	10	85

Table 5–5
Number of Accidents Predicted by Model Compared with the Actual Number

		Number of accidents	
Plant	Shift	Actual	Predicted
A	Day	21	21
	Night	14	11
B	Day	10	10
	Night	6	5
C	Day	10	11
	Night	4	5
D	Day	3	2
	Night	4	4
E	Day	2	4
	Night	3	6
F	Day	9	8
	Night	14	12
G	Day	19	17
	Night	6	8

rizes the entire modeling process, and the model predictions for each individual plant and shift are found in Table 5–5. The individual differences between actual and predicted numbers of accidents are not significant. The entire data set is summarized in a model with only four parameters, and the data can be considered to be well fitted by this model.

Estimated parameters, together with their standard errors, are shown in Table 5–6. All the parameters are highly significantly different from zero. The model can be interpreted as follows:

1. Increasing x_1 by 1 increases p, the probability of an accident, by a factor of $e^{.21} = 1.23$, i.e., by about 23 percent;
2. increasing x_5 by 1 (i.e., going from a situation where $x_5 = 0$ to one where $x_5 = 1$) reduces p by a factor of $e^{-.51} = 0.60$, i.e., by about 40 percent;
3. increasing x_6 by 1 increases p by a factor of $e^{.75} = 2.11$, i.e., it more than doubles p.

Now let us turn to the apparent difficulty with the model mentioned above, namely, that x_5 and x_6 refer to intershift rather than abso-

Table 5–6
Parameter Estimates for the Fitted Model

Parameter	Estimate	Standard error
Intercept	−8.34	
x_1	.21	.04
x_5	−.52	.22
x_6	.75	.25

lute measurements. It is argued that this does not invalidate the conclusions. Were it a problem, a more adequate model would also include baseline plant-specific effects, producing a model of the form:

$$\log\left[\frac{p_j}{1-p_j}\right] = \beta_0 + \beta_5 x_{5j} + \beta_6 x_{6j} + \phi_j$$

where the subscript j refers to plant j. The quantities ϕ_j are then unknown, and measure the effects of the absolute (rather than the relative) values of the variables, x_5 and x_6, which reflect sociological hypotheses. If the ϕ_j effects were large, this would lead to overdispersion,[11] one manifestation of which is that the deviance is substantially larger than the degrees of freedom. However, from Table 5–4, it can be seen that this is not the case; this means that the effect of the measurement of x_5 and x_6 being relative is small and does not invalidate the conclusions from the model. It is worth noting that, if the ϕ_j in the equation were important (and here they are not), their omission would lead to an underestimate of the effects of the sociological variables.

Conclusion

These results both question the validity of traditional approaches and validate the hypotheses drawn from the sociological theory. In a plant subject to a "danger level," which is a product of the "givens" assembled from outside, effective accident prevention is produced by workers who exercise autocontrol at all levels and by management, which in the absence of worker orientations favorable to autocontrol, engages in safety management as defined sociologically.

Final Observations

The sociological theory, as seen in this study, has shown itself capable of grasping a large number of the complexities of accident produc-

tion, and when variables derived from it are tested against those drawn from other theories has demonstrated a certain utility for explaining changes in accident rates. Such a result has critical implications for the whole field of accident analysis and prevention.

The rupture brought home the need for changes in theoretical perspectives on accident prevention, for new relationships between the professions and disciplines, and, for some observers, the need for new practices and research methods. This particular sociological theory of accidents was produced as just one of a whole body of responses to such demands. Its major hypotheses have been validated in a carefully designed series of empirical studies. However, the tests built permitted only limited investigations of a small number of hypotheses that can be derived from the theory. From questions relating to the nature of nocturnal routine work, the adequacy of the methods chosen for researching sensitive topics, and the collection of statistics, these studies have highlighted the need for both caution and interdisciplinary dialogue to accompany the development of the perspective.

Discussion of the relationship between statistical tests and the criteria of explanation developed is of relevance both for the interpretation of this and for the guiding of future research. The qualitative explanations presented in this chapter were constructed through an interchange between the workers' meaning constructs and the causal connections made through sociological analysis, and vice versa. Immediately subsequent to the research, a number of statisticians sought to test the hypotheses developed. Their results showed that the relationships established were not statistically significant; as such, the results lacked meaning adequacy for the actors researched. In the years subsequent to the original study's completion, the hypotheses were stated in a more precise form and a series of statistical tests carried out that demonstrated the validity of the explanations developed, which have been examined in this chapter. Had such results been available at an earlier period, consistent with Schutzian criteria, they should have been referred back to the workers to see if they were meaningful to them. Thus, certain connections made might have been tightened and others would surely have been loosened. In this way the explanations could have been refined, and perhaps even new hypotheses raised and further tests carried out.

The major debates in contemporary sociology that underlie the above discussion should not be permitted to overshadow the results of the research and hypothesis tests. These results, regardless of the limitations that can be placed on them, suggest that the sociological theory is

sufficiently powerful to merit further development, refinement, and integration into perspectives on accident prevention.

Since the rupture, some of the old approaches have changed and new practices have emerged. In addition, new risks, ones of potentially catastrophic proportions, present themselves in certain types of advanced industry. Such transformations will be analyzed in the next chapter. This analysis will trace the development of a new order within which prevention and compensation practices are being modified. An attempt will be made to locate the space into which a sociological theory might fit in this emergent order.

NOTES

1. T. Dwyer. 1981. *Industrial Accidents and Nightwork in the Manufacturing Sector.* Wellington: Department of Labour. It should be noted that this was originally written as a government research report, and for this reason some sensitive data were excluded. A fair amount of the descriptive material was changed to protect the anonymity that was requested by and guaranteed to companies and unions. The original report is a preliminary one, and some of the data gathered and reported are here presented in a different light subsequent to modifications, frequently induced by the research, of the theory.

   Interviews with staff always included a very early question: "Have you ever had an industrial accident?" which was followed by, "Have any of your workmates ever had an accident?" Starting from such a base anchors the interview in concrete events and not, as do most surveys of safety, in abstract concerns. All interviews obligatorily covered several other questions: what do you think are the most important causes of accidents in this plant? How can accidents be best prevented? Questions were asked pertaining to the individual member, organizational, command, and rewards levels, and their functioning and their roles in accident production. In addition perceptions of intershift differences and of accident causation differences between shifts were solicited. Interviewees were always invited to ask questions of the interviewer and to introduce observations of their own. Throughout the interviews, observational data would be introduced as would data from previous interviews, and this would occur especially where conflicts and differences were perceived. Over 200 people were interviewed giving approximately 900 pages of notes.
2. The reduction in labor turnover reflected national trends generally attributed to the retraction in the labor market due to national economic difficulties.
3. M. Crozier. 1964. *The Bureaucratic Phenomenon.* London: Tavistock.
4. A. W. Gouldner. 1954. *Patterns of Industrial Bureaucracy,* pp. 215–228. New York: Free Press.
5. A. Touraine. 1972. An historical study of the evolution of industrial skills, in L. E. Davis and J. C. Taylor (eds.), *Design of Jobs,* pp. 52–61 (p. 58). Harmondsworth: Penguin. (Essay first published in English in 1962.)
6. Ibid.
7. Gouldner, 1954, pp. 215–218.
8. T. Dwyer and A. Raftery. 1990. *Industrial Accidents Are Produced by the Social Relations of*

Work: A Sociological Theory of Industrial Accidents. Paper delivered to the Annual Conference of the American Sociological Association, Washington, D.C.

9. D. R. Cox. 1970. *The Analysis of Binary Data.* London: Chapman and Hall.
10. R. J. Baker and J. A. Nelder. 1978. *The GLIM System, Release 3. Generalised Linear Interactive Modeling.* Oxford: Numerical Algorithms Group. See also: P. McCullagh and J. A. Nelder. 1989. *Generalised Linear Models.* London: Chapman and Hall (2nd edition).
11. McCullagh and Nelder, 1989.

6

Readjusting the Prism

Remaking the Modern?

INTRODUCTION

Weaving an Explanation

One feature of the 1970s was a series of important renewals of safety and compensation institutions. In many countries safety reforms served to reinforce the standards approach and, in particular, the administration of standards by central government.

In 1970 in the United States the Occupational Health and Safety at Work Act (OSH Act) federalized, for the first time, industrial safety activities and laws.[1] Standards developed and applied in the private sector by safety engineering were adopted in federal government regulations.[2] Four years later, the Health and Safety at Work Act became law in Great Britain, and one of its main objectives was to unify state safety activities that had historically been subjected to functional scission. Examples of important legislative changes occurred in many advanced industrial nations: Italy in 1970,[3] Japan in 1972,[4] Sweden and West Germany in 1974,[5] France in 1976,[6] Norway in 1977,[7] and a number of Canadian and Australian states throughout the 1970s.[8] In the industrializing world and in the Eastern bloc institutions were also renewed, as in Brazil in 1975[9] and Czechoslovakia where reform occurred as early as 1969.[10] Virtually everywhere these changes increased the state's role as a standards fixer and administrator although, as in Britain and Sweden, elements of this entailed increased cooperation between state bodies, labor, and industry. Industries and activities, previously out of the reach of legislative supervision, were incorporated, legislation was strengthened, and government safety inspectors' numbers and activities

Table 6–1
Government Safety Inspectorate Members: France, United States, and Great Britain

	1947–1956	1957–1966	1967–1976	1977–1986
France	N/A	340 (1966)	475 (1971)	670 (1981)
United States (coal mines)	250 (1950)	285 (1957)	408 (1970)	1375 (1977)
Great Britain	322 (1950)	416 (1960)	618 (1969)	1450* (1980)

FRANCE: Figures from unpublished data provided by the Ministére du Travail, which refers to "corps d'inspection categorie A" of the "inspection du travail et de l'emploi." These were not available before 1966; it appears that the growth in the French inspectorate commenced slightly before the rupture, perhaps reflecting emergent tensions. In Table 6–2, the use of the alternate figures mentioned in Organisation Internationale du Travail, 1985 (cited below) would have given a 5.6% growth during the postrupture period.

UNITED STATES: Coal mines inspectors data for 1950 in Director of the Bureau of Mines. 1950. *Annual Report of the Director of Bureau of Mines to the Secretary of the Interior*, p. 150. Washington, DC: U.S. Department of the Interior. For 1957 see Director of the Bureau of Mines. 1957. *Annual Report of the Director of Bureau of Mines to the Secretary of the Interior*, p. 201. Washington, DC: U.S. Department of the Interior. For subsequent years data is from D. J. Curran. 1984. Symbolic solutions for deadly dilemmas: An analysis of federal coal mine health and safety legislation. *International Journal of Health Services* 14(1): 5–29. In the United States, most safety inspection systems were run by the states, and I have been unable to locate aggregate national figures. In coal mining, federal inspectors did not have the authority to enter the mines until 1941 and only from 1952 were they given any authority to enforce the law to prevent disasters.

GREAT BRITAIN: Data pre-1980 from the respective *Annual Report of the Chief Inspector of Factories and Workshops*. London: Her Majesty's Stationery Office, with exception of (*), which is derived from the International Labour Organisation. See Organisation Internationale du Travail. 1985. *Analyse comparative des rapports des missions tripartites d'évaluation de l'efficacitè des systèmes d'inspection du travail en sept pays d'Europe Occidentale*. Geneva: Organisation Internationale du Travail. The 1980 figure cannot be compared with earlier years because of administrative changes in the safety inspectorate. (The 1975 figures calculated on this new basis put the number at 950.) I have used the 1975 alternative to calculate postrupture growth in Table 6–2.

Organisation Internationale du Travail, 1985, beyond giving figures for France different from those quoted above (1970 = 257, 1980 = 401), gives additional figures for postrupture increases in inspectorates: Norway: 1972 = 133, 1979 = 470; Denmark: 1975 = 351, 1979 = 600; West Germany: 1969 = 1,764, 1979 = 3,000; and Italy: 1973 = 3,149, 1982 = 2,565. (The report explains this decline, the only one detected, in terms of a freeze in public service recruitment and early retirement.)

increased (see Tables 6–1 and 6–2). Employers were as a result obliged to augment investments to meet legal requirements, and many hired specialist professionals to interpret, enforce, and look beyond legislative demands. In many cases the legislative renewal represented the first changes of a substantive nature since World War I.

Compensation institutions, which since World War I, had undergone important changes in many countries, also underwent reform, particularly regarding benefit levels and contribution systems. Such reforms were less widespread than those which occurred with prevention. The most important innovation occurred in New Zealand, where no-

Table 6–2
Indices of Average Annual Growth: Government Safety Inspectorates

	Prerupture period	Rupture period	Postrupture period
France	N/A	7.9%	4.1%
United States	2.0%	3.3%	33.9%
Great Britain	2.9%	5.4%	10.5%

See notes to Table 6–1.

fault legislation covering all forms of accidental injury was passed in 1972.[11]

The state was not the only arena that changed subsequent to the rupture. Demand for the services of safety professionals grew with abnormal rapidity (see Tables 6–3 and 6–4). Specialist publications and academic interest in the subject mushroomed. Paradoxically, in spite of all this investment and change, the public in the world's most important industrial power became increasingly concerned about the risks of industrial accidents.

By the early 1980s the tools used to analyze the development of the separate institutions throughout this century no longer seemed adequate; it appeared as though the institutions had split open and turned on their sides. From an analytical viewpoint, the examination of prevention seems to be analyzed best as falling into three schools, which can be viewed as competing for influence within the contested terrain left behind by the rupture. None of these schools—the standards approach, the cost-benefit approach, or systemic safety—can be seen today as exercising a hegemony similar to that exercised in the past by safety engineering in the United States and state intervention elsewhere. Each school, to a greater or lesser extent, has succeeded in penetrating safety institutions, thereby transforming the terms of internal debates and the relationships between institutions.

The notion that "schools" have come to replace institutions as the key units of analysis is a novel one. This latter term, it should be recalled, aggregates functionaries, professionals, disciplines, and subdisciplines operating within specific politically defined spaces. Each school has a particular approach to analysis, each slices horizontally through the institutions and, in so doing, permits members of the same school to set common objectives in spite of the existence of boundaries that are disciplinary, professional, or administrative.

Table 6–3
Numbers of Safety Professionals: France, United States, and Great Britain

	1950s	1960s	1970s	1980s	1990s (latest information)
United States					
ASSE	7,000	7,300	11,000	18,000	21,000
(1911, 62 mbrs)	(1956)	(1964)	(1973)	(1984)	(1990)
AOMA	3,258	3,709	3,620	4,449	4,700
(1915)	(1956)	(1964)	(1973)	(1984)	(1990)
HFS	92	950	1,600	3,300	4,800
(1957, 92 mbrs)	(1957)	(1964)	(1973)	(1984)	(1990)
AIHA	1,000	1,300	1,900	6,000	7,500
(1939, 160 mbrs)	(1956)	(1964)	(1973)	(1984)	(1990)
ACGIH	N/A	620	1,500	2,500	3,000
(1938)		(1964)	(1973)	(1984)	(1990)
Great Britain					
IOSH	673	1,281	2,277	3,718	4,732
(1945, 146 mbrs)	(1955)	(1965)	(1975)	(1985)	(1988)
Ergonomics Society	50	238	480	600	850
(1947)	(1950)	(1960)	(1971–72)	(1980)	(1988)
SOM	550	1,050	1,050	1,750	N/A
(1935)	(1950)	(1960)	(1970)	(1985)	
France					
AFTIM	90	300	410	600	723
(1954, 90 mbrs)	(1954)	(1964)	(1974)	(1984)	(1988)
INRS		7	57	N/A	101
(1968)		(1969)	(1978)		(1988)

UNITED STATES: ASSE = American Society of Safety Engineers. AOMA = American Occupational Medicine Association (since 1988 merged with other groups and became known as the American College of Occupational Medicine). HFS = Human Factors Society. AIHA = American Industrial Hygiene Association. ACGIH = American Conference Government Industrial Hygienists.

The figures for United States organizations (with the exception of the AOMA for all years except 1990 and for foundation members) are drawn from the *Encyclopedia of Associations*, 4th, 8th, 18th, 20th, and 24th editions. Detroit: Gale Research Corporation. The AOMA figures are drawn from D. Walsh. 1987. *Corporate Physicians*. New Haven, CT: Yale University Press. p. 58, her figures are about 8 percent less than those quoted in the previous publication.

The control in Table 6–4 is made up by combining membership data from the American Medical Association and the American Society of Mechanical Engineers memberships taken from the above source. The only point of great interest here is the 5.5 percent annual growth in the latter organization's membership during the 1973–84 period.

For the United States and all other countries in Table 6–4 the growth of institutions is only taken after their initial foundation growth has stabilized to avoid questions of bias, eg. the HFS is thus excluded from the 1950s data and its contribution to the increase in the number of professionals is only taken from the 1960s onward, with all due corrections made for the purpose of percentage calculations so that its late inclusion does not create statistical artifacts.

Table 6–3
(Continued)

GREAT BRITAIN: IOSH = Institution of Occupational Safety and Health. Figures in personal correspondence of 3/30/88 from the Secretary, Mr. Barnell. Ergonomics Society figures for 1971–88 are drawn from the *Directory of British Associations*, numbers 3, 6, and 9, Beckenham: CDB Research Ltd., for 1971–72, 1980, and 1988, respectively. For 1960, derived from *Ergonomics* 3(1): 90–96 (list of members). SOM = Society of Occupational Medicine. Figures from J. T. Carter. 1985. Fifty years of medicine in the workplace. *Journal of the Society of Occupational Medicine* Jubilee Issue, pp. 4–22.

The profession used for comparative purposes in Table 6–4 was the Institute of Chartered Accountants of England and Wales. It was the only profession that disclosed figures in all three volumes of the *Directory of British Associations* consulted. To obtain earlier figures, the Institute's journal, *Accountancy* was used: April 1959 (p. 195) membership was put at 31,381; in July 1965 (p. 698) membership was put at almost 40,000; finally in June 1971 (p. 298), it was put at about 50,000, which is about 4 percent less than the 1971–72 figure from the Directory of British Associations. Figures given there were: 1971–72: 48,000; 1980: 56,169; 1988: 71,417; based on the discrepancies between the two sources I have estimated the 1965 membership at 38,000 (a higher estimate, of say 39,000, brings the prerupture rate of annual increase up to 4.0%)

The number of safety professionals is shown to have grown faster in the prerupture period than in any other; the two British texts that discuss safety professionals in the period make no mention of the record growth that has been depicted here. In J. Tye and J. Ullyett. 1971. *Safety Uncensored*, pp. 15ff. London: Corgi, are absolutely scathing of British industry's low level of employment of safety personnel. They discuss a survey indicating the presence of 1,261 full-time safety officers and 3,598 part-time safety officers in Britain. See also Robens (Lord). 1972. *Health and Safety at Work*, pp. 17–80. London: Her Majesty's Stationery Office. This observed growth is atypical and as such merits attention at a later stage: in the 33-year period investigated between the 1950s and the 1980s, the number of members of these safety organizations grew 5.3 times compared with 1.3 for the accountants in a slightly shorter 30-year period

FRANCE: AFTIM = Association Française des Techniciens et Ingénieurs de Sécurité et des Médecins du Travail. Figures contained in personal correspondence of 4/26/88 from the association's president M. Lafrance.

INRS is the Institut National de Recherche et de Sécurité. Figures for the number of researchers employed in personal correspondence of 6/10/88 from the Director of Study and Research M. Vogt.

There were an estimated 5,000 industrial doctors in France in the postrupture period, I have never found an indication of the number of engineers; however, contemporary France seems to fit, when compared with the United States, the image Tocqueville gave of one with relatively little participation in associations. It was extremely difficult to obtain information for France; one further association was unable to provide its own membership data, and requests for information to another fell on deaf ears. I could locate no directory or encyclopedia of associations for this country.

Table 6–4
Indices of Annual Increase in Safety Professionals

	Prerupture	Spanning rupture	Postrupture	Most recent
United States	1.2%	4.6%	6.8%	3.3%
Control	2.8%	2.3%	2.0%	1.4%
Great Britain	9.1%	4.8%	5.4%	7.1%
Control	3.0%	4.0%	1.9%	3.4%
France	N/A	3.7%	4.6%	5.1%

The institutional changes of the 1970s contributed to the restoration of social peace around the subject of work accidents. However, it appears that the threat of new accidents, ones that kill far more citizens than workers, is being felt in the advanced industrial nations. Mobilized citizens seek to make the potential costs of such accidents so high that firms will invest to prevent the Bhopals, Three Mile Islands, or Sevesos that threaten public lives. Such mobilization augments industry's preoccupation with accident prevention at the same time industry seeks to convince the public that its fears are groundless.

The structure of this chapter corresponds to the setting up and putting into motion of a loom. The schools are placed in position, one is contrasted with the other, and then horizontally a series of reflections are woven into place: these cover the limits of each intervention, institutional, social, and economic change, and include reflections drawn from historical data. As the weaving stops a series of impasses reveal themselves on several planes. In addition, some of the schools are recognized as tools that serve the emergence of new social forces. These observations demand that the cloth be picked apart and that we recommence by picking up the threads discarded from or poorly integrated into the former tapestry. The contours of a new school of accident analysis, prevention, and compensation, one compatible with a sociological analysis of the phenomenon, are then woven.

The Standards Approach: An Old School Reborn?

In the postrupture period new legislation was passed, standards widely brought up to date, and laws consolidated. The extent and nature of changes varied from nation to nation in a manner that may one day be subjected to close comparative analysis. Such analysis could try to understand, for example, why Italy was the only one of seven Western European countries studied by the International Labour Organisation to reduce the size of its inspectorate.[12] Kelman's comparative study examined changes in Sweden and the United States. One major finding was that it is not the search for the most efficient and effective mode of preventing accidents that determines the shape of choices relating to legally sanctioned standards, inspection, education, and similar activities, but rather the search for a solution compatible with cultural values and existing institutional arrangements.[13] In other words, standards were adopted as a function of a series of politically negotiated compromises.

In Kelman's analysis, hotly contested by Navarro,[14] the union movement is not seen as having played an important role in the legisla-

tive changes that occurred. Kelman's view helps us to understand why United States unions were, initially at least, lukewarm in responding to the OSH Act. In most countries, unions and their intellectual sympathizers develop one of two orientations: either they express satisfaction with and support for the status quo or they express dissatisfaction and seek more and better laws. United States unions modified their initial response and came to defend the Occupational Safety and Health Administration (OSHA) set up by the 1970 act. By 1978, a unionist would go so far as to claim that in the period of eight years OSHA had done more for safety than had been done in the previous 80.[15] Elsewhere, unions (in France the CGT and in Britain the TUC) demand more inspectors and better laws.

Even today it remains difficult to draw conclusions about the effects of such increased investments on accident prevention. Writers such as Kelman and Navarro would disappoint advocates of a structural approach by their failure to link their analyses of comparative institutional change to one of comparative changes in accident rates. An important number of advanced industrial nations report drops in both fatal and nonfatal accident rates, while simultaneously an increase in the severity of accidents is observed in some (see Table 6–5).

A number of hypotheses, some of which have little to do with changed regulatory frameworks, can be advanced to explain the changes. The recent radical restructuring of advanced industrial economies has taken labor out of the high accident rate manufacturing sector and placed it in the service sector. The number of hours worked in many Western countries has declined, thus reducing the risks of accidents due to the associated social relation. Subcontracting of dangerous tasks has been one response to increased legal surveillance; those who evade the law[16] are less likely to report accidents. Rising unemployment frequently results in greater labor stability as workers become less likely to voluntarily leave their jobs. Other things remaining equal, this entails a relative rise in average levels of qualification and a reduction in those accidents due to its absence. However, rising unemployment may be responsible for the lightly injured changing their patterns of accident reporting for fear of dismissal. Such a change would reduce overall rates, yet because it is difficult to hide more serious accidents, the severity of the average reported accident would be expected to rise. Of course, hypotheses such as these remain to be tested.

A deeper understanding of the impact of the standards approach can be gained from some research results. A study of Finnish power press regulations passed in 1974 showed that the mean period of inability to work due to relevant accidents dropped from 70 to 12 days.[17]

Table 6–5
Accident Rates: Contradictory Post-World War II Tendencies—
A Sample

	Pre-World War II	1945–1954	1955–1964	1965–1974	1975–1984
Falls or Stability					
Great Britain	0.09 (1932)	0.07 (1950)	0.04 (1960)	0.04 (1973)	0.03 (1982)
United States	0.15 (1935)	0.08 (1950)	0.07 (1960)	0.06 (1970)	0.06 (1975)
France	N/A	11.3 (1954)	10.3 (1960)	0.11(*) (1968)	0.07(*) (1982)
Rises					
Great Britain	29 (1936)	23 (1952)	28 (1964)	35 (1969)	N/A
United States	14.0 (1935)	9.3 (1950)	6.0 (1960)	8.9 (1970)	13.1 (1975)
France	N/A	0.7 (1954)	0.8 (1960)	0.9 (1973)	N/A

FALLS OR STABILITY: *Great Britain*: Manufacturing fatal accidents per 1,000 workers, in International Labour Organisation. Various years. *Yearbook of Labour Statistics*, Geneva: International Labour Organisation. *United States*: Fatal accident rate. Derived from the National Safety Council's Accident Facts, in R. de Reamer. 1980. *Modern Safety and Health Technology*, pp. 4–5. New York: Wiley. *France*: Accidents with lost time per 100 employees in all sectors for 1954 and 1960 from B. Solins. 1976. Une exploitation des statistiques nationales des accidents du travail. *Revue Economique* 27(3):433-482 (p. 462). For 1968(*) and 1982(*) compensated fatal manufacturing accidents per 1,000 employees from International Labour Organisation, various years. (In 1960, this rate was 0.10 and for 1968 Solins gives a rate of 8.7.)

RISES: *Great Britain*: Figures for all reported accidents per thousand workers employed, in Robens (Lord). 1972. *Safety and Health at Work*, pp. 291–292. London: Her Majesty's Stationery Office. *United States*: All disability accident rate. Derived from the National Safety Council's Accident Facts, in de Reamer, 1980, op. cit. pp. 4–5. *France*: Frequency of serious accidents per 100 workers, in Solins, 1976.

In the French construction sector, Wisniewski noted a regular decline between 1970 and 1979 in accidental foot injuries and a regular rise in fractures and sprains.[18] Changed managerial policies and inspectorate emphasis on the wearing of appropriate safety shoes, whether articulated through command level safety management or autocontrol, might explain the reduction in accidents to the foot but how does any analysis grounded in a standards-based approach explain the increase in fractures and sprains?

At a more global level, some recent evaluations of OSHA lead to a general conclusion that its actions have done little to reduce accidents, although the increase in the number of days lost may be due to increased reporting because of improvements in compensation in postrupture years.[19] Table 6–5 indicates some drops in accidents between the

1970s and early 1980s in France and Britain. However, in Great Britain in the early 1980s a different picture emerged with a rise of 24 percent in the fatal and major injuries rate between 1981 and 1984 in manufacturing,[20] and in the construction sector between 1981 and 1985 a rise of 50 percent was experienced.[21]

Singleton, one of the most important observers and researchers of industrial accidents, concluded in 1982 that "there is no proof as yet of the value of all the vast investment in safety research and legislation over the past decade."[22] In a later article based on a comparative analysis of Switzerland, the United States, and Britain, he was even more specific: ". . . bureaucracies are established and the lawyers and engineers are in firm control at the state, local government and big company levels. It is not going to be easy for the system to evolve the radical new thinking which is now needed."[23]

Looking Back to the Rupture

The rupture had questioned old safety and compensation practices and the response was to come in the form of the reinforcement of a standards approach to safety. The questioning had revealed the existence of a system that in terms of its publicly professed goal was a failure. In the United States legislators would react to the 29 percent increase in accident rates observed between 1961 and 1970.[24] In Britain a rise in accidents from 19.9 in 1962 to 31.7 per 1,000 employees at risk in 1967 was observed.[25] A French study concluded that there had been a decline in frequency rates between 1954 and 1969, but that accidents were becoming more severe.[26] In New Zealand changes in the industrial structure between 1951 and 1971 resulted in a shift of the labor force to safer industries, yet the anticipated reduction in accident rates was not produced.[27]

To complicate matters even further grave doubts were raised as to the utility of such statistics. Serious accident rates were estimated to be underreported by a factor of ten by Gordon and his team in the United States.[28] In Britain the sociologist Baldamus had earlier concluded that statistics gathered were an "unintended byproduct of the Factory Inspectorate's administrative functions. . . [as a result of which] very little attention was paid to comparability over time, even less for the use of figures for a causal analysis."[29] In France, statistics were seen to reflect different concerns—those of the insurance system and of employers—and for this reason they were seen to be of limited use for prevention. Such analysis led to a demand for new statistical bases that would give greater emphasis to the human rather than material elements of the accident.[30] In 1972 in Britain the Robens Committee concluded that collected

statistics were "intrinsically unreliable as measures of safety performance"[31] and one of its commissioned area studies went further: "information on the cause of accidents 'why an event occurred' is not collected on a routine basis."[32]

The chaotic situation of rising rates, critical analysis of the relationship between the origins and the utility of statistics, and the upsurge of social conflict over accidents led to a rash of studies in the early 1970s. It will be recalled that the key British research literature review to have emerged out of the rupture concluded in 1972 that gross deficiencies surrounded the existing notions of cause and prevention. "Far more research is required into the effectiveness of preventive measures . . . new methods of prevention need to be developed from the knowledge acquired through accident research . . . radically new theories are needed."[33]

Research funding grew. From virtually nothing in 1969, spending on safety research by the U.S. Bureau of Mines rose to $10 million in 1970 and $20.3 million in 1971.[34] In Britain a considerable amount of public monies became available for research at this time.[35] In France the state's Institut National de Recherche et de Sécurité (INRS) research staff increased from 7 in 1969 to 57 in 1978.[36] In New Zealand the output of research papers for 1975–80 was more than three times that of the period 1962–67.[37] Later, and especially in the United States, private foundations and university researchers showed an interest in a subject they had, outside of narrow specialist areas, virtually ignored for over half a century.[38]

Some of this research blazed trails and, from cost-benefit to risk analysis, helped provide intellectual bases for new approaches to prevention. In the case of the standards approach old foundations seem to have been built upon without great care for critical revision. However, from the beginning of the 1970s two schools were considerably strengthened: cost-benefit analysis and systemic safety. Both compete, intellectually and politically, with the standards approach and it is to them that attention shall now turn.

SCHOOLS OF ACCIDENT PREVENTION: CHILDREN OF THE RUPTURE

Cost-Benefit Analysis

Cost-benefit analysis systematizes Bird and Germain's idea discussed in Chapter 2 that prevention should be seen as a paying activity. This school proposes that all costs incurred in a firm, including safety, be

submitted to rigorous study in order to calculate the benefits they produce. Investments should be made or rejected according to study results. The school, as it gathers force, has expanded beyond its initial reference to individual firms and has been proposed as being capable of application at a societal level.

The application of this approach to safety is relatively recent. In 1972 Sinclair produced a volume for the Robens Committee entitled, *A Cost-Effectiveness Approach to Industrial Safety*[39]; Ellis's 1975 literature review found that the whole cost-benefit area had been poorly analyzed.[40] Even as late as 1977 Rinefort was able to say, in introducing an empirical study, that such analysis had been applied to the "field of occupational safety in only a few instances."[41]

Rinefort analyzed a sample of 140 Texas chemical paper and wood manufacturers of various sizes and found that

> a better combination or mix of . . . various safety activities rather than greater monetary expenditures for some of them was frequently the best way to reduce work injury costs. . . . The most effective mix, therefore, would seem to be a balanced approach which combines both engineering and non-engineering and which probably places more emphasis on non-engineering aspects. . . . in these times when increased emphasis has been placed on performance and cost control this information should be of interest to a number of organizations.[42]

Since the end of the 1970s much work has been carried out within this school. Two distinct camps line up therein: one with a narrow definition criticizes other approaches, specifically the standards approach, as uneconomic and seeks their substitution by approaches supported by cost-benefit analysis; the other camp has a broad definition and argues that employers should be forced to bear the real costs of both accidents and the disobedience of standards and safety regulations, which if done would result in higher safety levels.

The Narrow Definition Camp

Various discrete areas of study can be identified within the intellectual work of the narrow definition camp. One key underlying notion is that firms should not be forced to obey perhaps meaningless regulations, but should instead be charged the true cost of all accidents that occur. To decide what are "true costs" is no simple matter. Viscusi has made one attempt; using survey data and objective indicators he calculated that U.S. manual workers valued loss of a limb at around $10,000 and life at over $1 million.[43] Another method is to ask workers to value their own limbs; a Brazilian study did just this in Sao Paulo state. It found that rural workers gave accidents to their limbs a quarter of the

value attributed by their urban counterparts.[44] In another variant, it is assumed that workers have perfect knowledge of the dangers of different jobs, thus a "danger market" is perceived to operate and it is hypothesized that higher wage rates are paid to attract workers into the more dangerous occupations. One United States study has estimated this differential at between $375 and $420 per annum.[45] In a further version it is posited that firms should no longer be obliged to adhere to safety standards; instead, an injury tax should be levied that reflects the real costs of accidents, and in this way firms will be able to freely decide what prevention policies best suit them to avoid accidents and their associated taxes.[46] The notion that underlies these ideas is that by analyzing accidents in accordance with such methods, employers will be motivated to pursue their interests and will make safety investments that will result in profitable reductions in accident costs.

Unearthing Perverse Effects. A by-product of cost-benefit analysis research has been that various negative effects of the introduction of standardized safety measures identified during the 1800s have been rediscovered in a contemporary setting. The ineffective investment effect results when a measure designed to reduce one technically defined accident cause is applied in workplaces where that cause does not exist, or when the measure to be applied is incapable of reducing accidents of the targeted type. Numerous examples of the latter are to be found in accident literature. A machine-guarding standard's chart that had been applied for decades in the United States was found to have been incorrect.[47] A series of U.S. surveys showed that respirators did not fit most faces, that two thirds of safety shoes were deficient, that 20 of 21 tested safety helmets had important design defects, and that 50 percent of glass goggles failed impact tests.[48] The 1969 Coal Act in the United States redefined all mines as gassy. This forced owners of mines that were previously classified as nongassy to invest in ignition explosion prevention. Such mines employed 45 percent of miners, yet accounted for only 6–7 percent of gas ignition deaths. This requirement, true to the prediction made by an owners' representative, was followed by the closure of nearly 600 small nongassy mines by 1974 and more in subsequent years.[49] These regulations have been analyzed as being a political means by which big companies, supported by unions, could eliminate the smaller ones from the market; thus, the regulations can be seen as having a lot to do with interests and little to do with accident prevention. Where explosions are not a danger, adherence to the regulations constitutes an extreme form of the ineffective investment effect. Where such mandatory investment channels money away from the prevention of

what are more important technical causes of accidents, such as roof falls or transportation accidents, an accident inequality effect is produced between these mines and those subject to effective investments.

Regulatory bodies fix standards to transform safety-related conflicts and other conflicts expressed in the name of safety into administrative matters. This can be done without attention being paid to the social (measured in reduced accident rates) or economic effects (measured in savings made through accident reduction). It thus appears that the origin of ineffective safety standards, which placate conflicts, give the illusion of safety, and favor interest groups, is eminently political.

The new accident effect is the subject of attention by members of the cost-benefit school. In his early text Rinefort found companies that experienced both low accident and safety costs, and he explained that prevention efforts therein were based on practical experience; in companies where both the costs of accidents and the costs of safety were high he observed that prevention policies emphasized "compliance with governmental standards and regulations rather than injury prevention."[50] The conclusion to be drawn is that increased safety investment raises accident costs over and above what they would have been had a policy of "practical experience" been followed; in other words, one must add together the investment costs resulting from both effective and ineffective investments and then add on the rise in accident costs due to those new accidents that are produced as a result of the policies adopted. Rinefort does not, however, expand on this second phenomenon. Canadian researcher Jones provides some insights into the new accident effect. He observed low accident rates in firms that did not accept standards and high accident rates in firms that adopted them. His explanatory hypothesis evokes the notion of a new accident effect and is compatible with sociological rather than economic analyses. Visible dangers increase vigilance and workgroup efforts to control danger, and the absence of such dangers is associated with routine work and with a propensity for even minor workplace disorganization to result in accidents: "Since hazards cannot be eliminated completely, there may be a tendency for persons to lower their defense and operate more carelessly when no danger is evident."[51]

Conclusion. The analytical guns of this camp can be equally trained against state and professional demands for the adherence to safety standards. The standards approach neoliberals, who principally adopt a narrow definition, argue has produced a century-and-a-half of irrational safety management. It is time to let such management be guided by the market, and cost-benefit analysis is the tool that permits this.

The Broad Definition Camp

This camp argues that accidents occur because firms are not forced to bear their full costs. Such reflection takes place in various strata. From Daniel Berman's viewpoint, a first area for attention would be for compensation to at least cover the wages lost by victims. He estimated, in the early 1970s, that officially recognized victims recuperated only one fifth of their wage loss through compensation.[52] Going beyond such a definition of loss in simple pecuniary terms is the notion that others, emotional or affective losses, for example, should also be "compensated." Carpentier put the position thus: "the notion of productivity, previously based on considerations of unitary cost and of volume of production, evolves towards a measure of total economic cost including long-term charges with relation to technology, organization, and psychological and social consequences."[53] The repercussion of such an opening of notions of accident costs would be to bring the damages awarded to industrial accident victims closer to those of victims of other categories of accidents produced through work. For example, in the United States compensation to victims of airline accidents or medical malpractice can run above the million dollar mark; if employers were forced to compensate workers and their families at similar rates, the benefits to be acquired from safety expenditure (measured up against reduced compensation payments or insurance premiums) would, in the argument of those defending a broad definition, stimulate massive safety investments.

But the discussion thus far has only examined the necessity for firms to compensate workers and their dependents. The Bhopal accident pushed the frontiers of compensation costs to include a large third-party civilian population. Chernobyl went even further, affecting crops and production in neighboring nations and possibly, through genetic mutations, future generations. The proponents of cost-benefit analysis argue that industries should be forced to bear the cost of their accidents, but the limit of such ability has always been in a firm's capacity to declare itself bankrupt. Those in the camp that demands a broad definition ask on what basis the costs of damage external to the workplace are to be assessed and what mechanisms can be used by a cost-benefit approach to ensure that industry bears such costs?

Within this camp a further stratum of analysis exists: its principal hypothesis is that safety laws are not obeyed because the costs of disobedience are insufficiently high to stimulate investment. Gleason and Barnum examined rates of government inspection in the United States and concluded that the average factory would be visited about once a

century. They referred to a General Audit Office study that found that numerous violations were not cited by inspectors, and furthermore that wide regional discrepancies in citation rates existed. Similar observations can be made about a variety of other countries,[54] but the conclusions of these authors are of interest here because they are framed in cost-benefit terms: "the opportunity cost of correcting almost any sanction will be far greater than the expected cost of sanctions. . . . [these] almost invite the employer to violate the law because the differences between compliance and sanction costs are so great."[55] The authors pay passing recognition to the need for corrections in OSHA, but their analysis leads to one simple conclusion: laws will be obeyed only if mechanisms are developed to raise inspection levels and penalties.

The Two Camps: Conclusion

Ashford has succinctly summed up the underlying perspective of the cost-benefit school: "safety pays when you are forced to bear the cost of an unsafe workplace."[56] The camps separate on the question of which costs are to be included in calculations and who is to bear the burden.

Whichever camp one refers to, one can find two important critiques being leveled at this school; both critiques refuse to accept the legitimacy of the grounds on which cost-benefit analysis is based. One combats the school's supposition that life, limb, family ties, or friendship can be reduced to monetary measures that compensate for their loss. It argues that these are unquantifiable, that they are priceless, and it defends human values against their reduction to market determined costs. Beyond being rooted in humanistic values which refuse the tenets underlying any attempt to reduce life to a series of economic calculations, this critique is grounded in many practices of the advanced industrial nations. For example, democratic societies spend huge amounts of money to defend and guarantee civil liberties and freedom; there is consensus that these values are supreme; and that neither the costs nor benefits of the spending necessary for their defense should be calculated. Why then should the value of life be calculated—is it not an equally supreme value?

The second critique defends a form of social justice that the school destroys. The calculation of the cost of life implies that safety should be organized to protect the most "valuable" lives. This attribution of different values to different lives is unjust, and it results in calculations that determine that the lives of the rich and powerful are worth more than those of the poor and powerless. The wealthy invest huge sums of their own and of public monies in saving themselves and their kin from ill

health and death; why should a manual workers' physical integrity be worth any less? It is hard to formulate an answer to this question that does not result in cost-benefit analysis being seen as a tool of injustice in the service of the powerful.

Systemic Safety

In its pure form systemic safety appears to offer a response to the two critiques of cost-benefit analysis. Systemic safety is the term I will use for those conceptions of safety management that claim to be able to calculate and plan safety so that life chances are statistically equalized and, in its pure form without reference to costs, losses virtually eradicated. In this sense it can seize the ethical high ground by claiming to protect life at any price.

Accidents are avoided through meticulous prior study, planning, and design of the production system. "Technical fixes," from robots to foolproof machines and totally planned workplaces, are just some of the equipment and strategies in the service of systemic safety professionals. Cost criteria are absent from recommendations made, for example: robots may be recommended simply because they are "ideally suited for repetitive, boring, back-breaking and hazardous jobs, the lousy jobs that nobody really wants."[57]

It is through adequate investment in study and design that systemic safety claims to be able to plan production to reduce risks of accidents to an absolute minimum. It uses this claim in its attack on the cost-benefit approach's ethical treatment of life. Let us briefly examine a well-known example from the area of public safety: an automobile manufacturer calculates that its new model will sell 400,000 cars; a safety engineering change is estimated to add $11 to the price of each car; this would cost consumers $4.4 million and would save an estimated six lives. With the market value on a life calculated at $400,000, it would be an uneconomic investment to change design. This analysis, presented by MacGregor and Slovic, is an approximation of that made by Ford in the case of its Pinto model. Cost-benefit analysis was used in a decision not to change fuel tank design and deaths resulted.[58]

Systemic safety identifies technically defined causes of accidents and analyzes their prevention, but in the real world economically or bureaucratically guided decisions commonly ignore such analysis. In the U.S. System Safety Society's journal the moral justifications of such decisions are questioned. "Is cost the primary driving factor? When it is more beneficial financially to manufacture a defective product than to incur the cost of correcting its unsafe aspects, how do safety ethics influence management considerations?"[59]

In noncompetitive sectors of the economy systemic safety can strive toward its ethical ideal, one in which the profit-safety dilemma is resolved. How can this be transferred into the competitive sector? Analyzed from an economic viewpoint such a transfer would take place only where each life had an infinite value placed on it; such a formula is, however, totally unrealistic. In a less radical sense we can imagine it being readily transferred, in a nonpure form, to those industries where accidents entail numerous human victims, high compensation payouts for each victim, and significant material losses. One sector that would seem to be so subjected is commercial aviation. However, Lederer, a former director of NASA Manned Space Flight Safety, lamented that such an expectation was not realized:

> There are many examples in aviation where time taken to apply system safety concepts would have prevented grounding of aircraft, great personal embarrassment to engineers, expensive delays in operations, defamation of corporate and national image, presumed laxity of management, loss of enormous resources and many lives. The prevention of these undesirable events . . . is the objective of system safety.[60]

How can this school expect to penetrate the competitive sector if it is not resorted to in a case that appears almost ideal from an economic viewpoint? By turning to the political arena another method of penetration can be envisaged: the production of institutional demand for a professionally closed school. Such demand would be of a form similar to that existing for doctors and lawyers in most advanced Western nations. The first step in this direction would be to form a labor force versed in the principles of systemic safety; subsequently, political action would restrict right of entry into the profession and guarantee a monopoly over the practice of certain safety activities, with such a monopoly being defended in the name of "high moral values developed in an effort to improve the quality of service rendered."[61]

At the same time as professional closure is mooted and a path toward it slowly trodden, systemic safety in all its variety continues to develop as a school. Fault tree analysis is refined, single point failure analysis introduced, and applications in new areas researched.

In its pure form this school attacks the predominance of profit over life in the name of ethics. However, in its pragmatism it reaches out for support from industrialists, and it does this by counterposing its aims to those of the administration of standards through regulations. A rallying cry becomes: "Professionalism with strong ethics is better than laws."[62]

From the point of view of the union movement, embattled on the accident question, systemic safety makes claims that identify it as the most attractive of the three schools. Construction work theoretically can be conceived of so as to make it as safe as office work. The school,

through its studies, can claim a capacity to reduce all accident risks to a minimum, subject to appropriate investment.

Through vying for professional closure, having a basis of political support from sections of employers and unions, and undermining the standards school, systemic safety promises to strengthen its role in the competitive sector.

The Formation of Contemporary Relationships between Institutions and Schools

Two concrete effects of the rupture were the sharp increase in demand for safety professionals and the wide-ranging reevaluation of accident prevention activities. New demands came from governments and employers eager to restore social peace and preempt further disruption in industry and from unions which acted both in response to worker demands and because they saw safety as a means of mobilization. Reevaluations came from employers who rediscovered accident costs and questioned the efficiency of legal standards, from governments that doubted the effectiveness of state intervention, and from unions that started speaking out on a problem they had largely ignored. Professionals, especially those subjected to conflicting external demands, reflected on their roles and modified their actions in a number of important ways. If the penetration of the schools into the institutions was not visible in immediate postrupture years, the same could not be said by the mid 1980s.

Texts reveal the dramatic reorientations that took place within professional bodies. The American Society of Safety Engineers (ASSE), for example, showed no embarrassment in an official statement summarizing developments between 1970 and 1986, in discussing the wide variety of new activities, techniques, and clientele it had dealt with.

> Robotics, lasers, automation, new industrial hygiene and environmental pollution concerns, military and civilian nuclear power use, computers and energy conservation emerge. Ergonomics . . . fault-tree analysis, cost/benefit relationships, behavior modification, and litigation are common. ASSE is now responding to all these areas of concern.[63]

In a further demonstration French ergonomics could be seen by 1985 to have integrated diverse demands with the result that cost-benefits and standards schools engaged in debate within the institution.[64] In the United States OSHA considered the possibility of substituting standards with economic incentives.[65] The French state research agency for safety, the INRS, a traditional defender of standards, published material promoting fault tree analysis and in so doing reinforced the pretensions

of systemic safety.[66] In an area of safety and welfare concerns, Duclos observed, from 1984, the emergence of explicit cost-benefit analysis in some decision-making processes of the French state and that engineers moved toward systemic safety.[67] In Britain state institutions came to "freely adopt the CBI's [Confederation of British Industry] language of the applicability of 'cost-benefit' analysis to aspects of health and safety . . ."[68]

Not only did the institutions "open" in the direction of integrating schools previously treated as incompatible, but the schools openly vied for bases within a variety of institutions. The System Safety Society published a draft of by-laws, effective from 1987, in which it openly sought "to expand its membership to include professionals from . . . all fields of Engineering, Human Factors, Medicine, Science, Law, Education, Management etc."[69] States, which have traditionally recruited and applied engineering knowledge in the form of standards, opened new spaces for doctors, ergonomists, and psychologists. The traditional archenemy of legislated safety standards in the United States, the ASSE, passed into the active role as counselor to the legislator.[70] The cost-benefit school reached out for varied professional support and contributions; we have already seen Rinefort's suggestion that behavior modification techniques may be of greater cost effectiveness than further engineering controls.[71] The school found sympathy with United States doctors[72] and French ergonomists,[73] not to discount the traditional engineering backing and a new base of support from systemic safety, expressed in the hybrid term, "risk-benefit analysis."[74]

While no quantitative data are available, and neither are studies that seek to estimate the penetration of the schools, the current situation can be tentatively summarized as follows: the school that arouses the strongest and broadest-based support is the standards approach; the cost-benefit school arouses the most vigorous opposition, and even though it has strong backing, it appears to draw on the narrowest base of political support. In the case of the former some professionals see the promulgation of standards as the best means of expanding demand for their services,[75] and for most unionists the enforcement of a modern and logical system of standards is generally perceived as the best available means for increasing safety,[76] a view shared in various postrupture governmental inquiries. Certain segments of employers, and an example from the United States mining sector has been referred to, also support this approach. The strongest attacks directed at standards come from opponents who seek to weaken demand for state intervention: liberal governments in the 1980s, and competitive sector employers and professionals who seek to fill the vacuum the school's demise would

leave. The cost-benefit school draws the bulk of its support from such bases, and it should not be too surprising after discussion of its broad definition camp that unionists may support the school up to the point that its calculations are seen as increasing safety investments but pass on to the attack from the moment that its calculations serve to limit such investment.[77] Opposition comes from the other schools and specifically from safety professionals who defend their ethical values against the assault on them that cost-benefit calculations represent: ergonomists, doctors, and engineers.[78]

It is in the space left by opposition to these two schools that an important part of the social and political base to the systemic safety school grows. Its claim to offer "total safety" allows it to recruit support from all those who criticize the other schools for their social ineffectiveness or for their placing a higher value on money than on life. In addition, its intellectual origins are in the scientific field and it has been postulated that it will, because of this, become the dominant school from the viewpoint of safety research; in this way it obtains ready support from a rising technocracy. Finally, backing emerges from sectors linked to the trade union movement, those who argue along lines that "the rights of workers to health and safety are of paramount importance and must override the other considerations that may be adduced to remove or limit them."[79] In spite of opposition from already-discussed sources and considerable criticism of the "unrealistic" nature of purists' goals, it is difficult not to be impressed by the vigor of this school, by its spread beyond the noncompetitive sector, and especially by its penetration into disciplinary, professional, and other institutional discourses and practices. In any attempt to understand the future of accident prevention, more attention must be paid to this school.

Before doing this, however, let us focus briefly on one traditional element of the accident picture that has yet to be treated in the postrupture context: compensation.

COMPENSATION

The general picture in postrupture years was that some governments mounted inquiries and reformed compensation institutions. Worker agitation around the issue occurred in France and Canada. In the United States courts became more liberal with respect to the awarding of damages to passive victims of work accidents: passengers, patients, consumers. These, in turn, filed an increasing number of claims.

In Canada injured workers, dissatisfied with benefits gained as isolated individuals, organized politically and formed an association in 1974.[80] In France the half-a-million-strong Association of the Working Wounded accentuated its traditional narrow pecuniary focus, rejecting those modifications to prevention legislation that it interpreted as indicating a return to common-law practices of compensation. According to Juffe, this was done in a narrow corporatist manner without any interest being shown for the preventive question.[81] In general, worker action seeks to increase benefit levels and to reduce the loopholes through which employers (or insurers) can escape making such payments.

In 1972 a report on the relatively liberal provisions (for the United States) of the New York State compensation scheme found that victims "suffered severe economic attrition and adverse changes in quality of life."[82] This report fed into the National Commission on State Workmen's Compensation Laws that found that many state laws did not adequately attain their main objectives: rehabilitation, restoring lost wages, cost-efficiency, and prevention.[83] In New Zealand a Royal Commission had reached similar conclusions in 1967 and produced innovative recommendations that broke with the approach the country had adopted from Britain around the turn of the century.[84] The 1978 British Royal Commission on civil liability and compensation for personal injury headed by Lord Pearson recommended minor modifications to the existing system. It insisted on the nondifferentiation of levies according to sectorial accident rates and, in contrast with the abolition proposed by its New Zealand counterpart, a continuation of victims' traditional right to sue.[85]

In France the 1976 law reinforced assistance to victims at the same time that it reorganized compensation funding so that firms be made as liable as possible for the costs of the accidents they produce.[86] In Britain the legal changes made built on the foundations of the past.[87] In the United States some of the changes that had been recognized as necessary in 1972 were made, and in 1974 benefit levels came to surpass their pre-World War II levels for the first time.[88] During the 1970s compensation entitlements increased in a substantial number of states.[89] Beyond these three countries we find other examples of reform: in Sweden, where the compensation levy had been differentiated by sector, it was suggested that this be changed toward a single universal rate in 1972.[90] Neighboring Norway incorporated compensation into the social security system in 1970.[91] In general, changes in compensation for work injuries emphasized reform to, rather than a break with, existing institutions. In so doing, the systems built up from the end of last century were largely

retained and their range of action extended to new sections of the workforce; in addition, benefit levels were frequently raised and levy systems altered.

The New Zealand Exception

Within this overall picture of continuity one small advanced Western nation made a clear break with the past. In 1973, under a law passed a year earlier, a universal state-run scheme to compensate all (work and nonwork) accidents replaced a privately run system that was seen to inadequately compensate work injuries. This scheme has met with wide interest among academics and from various Western governments. Analysts of phenomena as diverse as product safety, industrial accidents, and medical error agree with the essence of Kaim-Caudle's judgment that it may "point the way in which social policy in the developed countries will advance."[92]

The traditional system, which treated victims of identical accidents differently simply because one victim had been engaged in paid work and the other had not, and which treated paid workers differently with some winning damages in civil claims and others not, was perceived as unjust. This consideration formed an important element of the reflection that supported the innovative law. Through the centralization of compulsory automobile and work accident insurance levies in state hands, the high costs of intermediaries would be removed, which would permit both an extension in entitlements and a rise in benefit levels without increasing costs. A modest transfer of revenues from general taxation would add further resources and permit an even further extension of entitlements. By removing common-law claims and paying victims of all accidents earnings-related compensation, past injustices of unequal treatment would be eliminated. Finally, by according first priority to prevention and second priority to rehabilitation, a more rational and humane society would be built.

Tort law, private insurance, and the traditional distinctions between work and nonwork accidents were eliminated. Totally disabled victims, whether of sporting, work, medical, domestic, or automobile accidents, shall receive 80 percent of their wages at the time of injury and for as long as the effects of injury persist; less than total incapacity shall result in reduced payments. For the unemployed, unsalaried houseworkers, and similar categories payments shall be made on the basis of an estimate of potential future earnings. All payments are to be inflation adjusted, awarded independently of fault, and additional lump sum pay-

ments are to be made for death, permanent loss of physical or mental capacities, and suffering.

With perhaps one exception,[93] analysts are unanimous that no overt social or political pressures had emerged in New Zealand to compel changes of the type suggested by the 1967 Royal Commission into Compensation for Personal Injury. Rather, it has been suggested that a form of social consensus was eventually reached that the proposed reform was both rational and just.

A North American research team headed by Kronick provides what is, to my view, the most perceptive analysis of the intriguing issues surrounding the support for and the breaking down of resistance to the proposed system. The acceptance of the idea that accidents are produced by social processes, the recognition of the need for community responsibility for accidents, and the right for individuals to protect their standard of living constituted a set of perceptions that came to be shared by all significant actors. This sharing was seen as laying the political bases for the New Zealand reform.[94]

The Royal Commission had seen accidents as a statistical outcome, one that varies with the level of national social and technological development. Such undesired events therefore can be understood as products of economic development: the whole society benefits from development and therefore has the responsibility to bear the costs incurred by its statistical victims. The victim was seen as a passive product of an acting system; for this reason all victims have the right to benefits, and the concept of community responsibility is the foundation on which this right is argued and guaranteed.

Kronick and her team observed that all social actors recognized the need for changes in the old compensation system since it was both unjust and inefficient. The Royal Commission set about rectifying this situation and did so in an entirely innovative manner in which "it drew a logic among the values which enabled acceptance of the controversial value, community responsibility, through its link to other universally supported values.[95] Their research report explains these values: "Injured citizens are viewed as having abided by the rules or laws governing society and having participated as they should in furthering common good. As a consequence they have been injured. In turn, fairness and justice should prevail in their treatment."[96]

The compensation system based on the Bismarckian model had transferred the onus of responsibility for work accidents and their compensation from employees to employers.[97] Now the pioneering New Zealand system moved the responsibility for the production of accidents

from employers to technological progress and responsibility for their compensation to beneficiaries of this progress: the society as a whole.[98]

The United States Modification

Important nonstructural change has occurred in the compensation arena, which concerns the consumer victims of accidents produced by work processes judged to be defective. In recent years, the costs of compensation to companies and individuals for their accidental acts rose to previously unimagined levels. The judicial system, as a function of a new orientation, has awarded increasing sums to victims of medical malpractice, airline disasters, and product failures.[99] Victims of work-induced psychological stress and other related complaints are also winning important damages.[100] This is not the place to detail the complexities surrounding such modifications; however, we can be sure that the success of some in gaining awards has stimulated others, aided by lawyers who establish reciprocal financial interests with accident victims, to seek them. One example illustrates: by 1974 1 New York doctor in 10 was being sued for malpractice, whereas five years earlier 1 in 23 was being sued.[101] Workers, frequently unable to sue their employers for damages because of insurance regulations that limit their rights, seek to increase their compensation by other means and constitute nearly a half of those winning damages in product liability cases. In such lawsuits faulty products (machinery, materials) made by third parties are claimed to have caused the accidents.[102] It is common to see the idea being expressed in the literature that the continued increase of such cost pressures, in the absence of the imposition of legal ceilings on damages, may eventually make the move toward a no-fault insurance system irresistible.[103]

Picking up the Threads: Changing Compensation in a Wider Context

Introduction

It can be hypothesized that developments such as those just outlined for the United States and New Zealand are supported by three specific cultural transformations among subordinate actors: a change in the cultural perception of death, a perceived generalization of and increased exposure to risks, and the combination of public faith in and mistrust of the dominant methods of managing these risks. To arrive at an understanding of this seemingly complex set of hypothesized changes, I will need to digress considerably in order to examine each in turn. In so doing, concerns relating to accident production will be re-

united with those relating to compensation, and some of the social bases for the eventual consolidation of what, for want of a better term, shall be referred to as a "sociological school" of accident analysis and prevention will be located. In this discussion lengthy reference will be made to North American literature on systemic safety.

Perceptions of Death

Attitudes toward death in the West were transformed parallel to the rising control over life that was associated with the growth of industrial society, a control attributable to factors such as sewage systems, public health and hygiene, and later, vaccinations. For Philippe Aries the death of the other became more socially important than one's own death. From the beginning of the twentieth century Aries detects another change: the rise of a "modern attitude" toward death, where death is forbidden in order to preserve happiness. This interdiction, born in the United States, was "built up on the ruins of Puritanism in an urbanized culture which is dominated by the search of happiness linked to the search for profit."[104]

But how can death be "forbidden"? One response is found in the way that it is set away from modern lives both through the establishment of institutionally separate spheres for its management and through the building of culturally constructed defense mechanisms to avoid reflections about it. "High-tech" medicine seeks to provide another type of response, and the whole United States' medical profession is forced to pay the price whether through public discredit[105] or through the intermediary of the legal system in the form of malpractice suits. The "cult of the body" seeks to turn back natural aging processes, cinema screens project immortal characters, and systemic safety promises a planned future of freedom from industrially produced death. The other side of Aries's observation relates to the imperative to preserve happiness: leisure, job satisfaction, and "good living" have become industries. Pleasure and rules for its attainment are provided in manuals, videos, and mail-order courses and, from Club Med to packaged fitness or sex programs, "happiness" is planned by specialists. The immortality and happiness industries are knowledge industries: through investment in market research they seek to identify consumer needs and desires; through investment in applied scientific research they try to create the "right" technology—the formula capable of satisfying individual desires; through investment in marketing they seek to package the formula so as to appeal to defined market segments; and through investment in advertising (of various forms) they seek to "educate" or to

"manipulate" potential buyers. These industries have investment patterns that are postindustrial; instead of seeking profits and productivity by investing in the transformation of working conditions, strategic investment takes place in the production and dissemination of knowledge.

Concrete social actors seek to produce a supply of services offering immortality and happiness, and to produce a demand for these. The whole field of culture becomes subject to their production. An important segment of these actors comes from the knowledge-based professions that have built themselves privileges through their defense of ethical values: life, liberty, and security. In recent times it has become clear to many of these professionals that the constraints of competitive industrial capitalism do not permit the unfettered promotion of such values. In the specific area of industrial safety actors often integrate conflicting goals in such a way as to preserve their value system. Mechanisms are developed to bypass conflicts: complex negotiation processes are engaged in and scapegoating is resorted to in order to blame accidents on individual human inadequacies. Those professionals who reject such integration may engage in action that reflects a desire for scission: associating with like-minded professionals or joining militant unions or COSH-type (Committee for Occupational Safety and Health) groups. Other may be led to redefine their actions and to merge into a new elite. This elite, through its access to knowledge and its capacity to experiment and plan, acts to bypass the constraints imposed by industrial society and its intermediary institutions. Frequently referred to as the technocracy, its aim is to build a society where human needs will be satisfied and new ones created in a planning process that has as its base investment in science, technology and the management of knowledge.

Public Fears of Exposure to Risk

The growth in importance of this technocratic elite can be viewed as but one effect of a cultural change that has created new demands, demands that this elite claims to satisfy. Some United States surveys have shown that citizens perceive themselves as facing greater risks than in the past. Such feeling, as illustrated by one survey, is unevenly spread: 38 percent of top corporate executives, 60 percent of investors and lenders, and 78 percent of the public perceived themselves to be exposed to greater risks now than 20 years ago; in the same groups, 36 percent, 13 percent, and 6 percent thought they were exposed to less risks.[106] Major responsibility for the increase of perceived risk has been attributed to some specific sectors, which ironically, are major users of systemic safe-

ty. In many industries that process high-risk materials—nuclear power, genetic engineering, and dioxine manufacture—elaborate safety planning is a prerequisite for production. Such planning results in the design of technical processes that are frequently claimed to have a probability of producing a serious accident only once in hundreds or even thousands of operating years. In such industries the calculated probability of fatal accidents is far lower than that of more conventional industries, yet the public expresses greater fear of them!

It is difficult to understand why the public feels it is subject to greater risks than in the past. In the United States, where issues relating to risk assume major political and economic importance, contemporary life expectancy is 72 years, a vast increase from the 50-year expectancy of a century ago.[107] Such a simple observation, that risks to life decline empirically at the same time as fears of them rise, forms just one basis for a whole new field of research. A Society for Risk Analysis was formed in the United States in 1980 and expanded to Europe in 1986; it sought to organize and promote the study not only of risk production but also of the social, economic, and ethical acceptability of risks.[108] Reflecting this context, and perhaps seeking to repeat the role it had through Crystal Eastman's work on compensation at the beginning of this century, the Russell Sage Foundation made the subjects of risk analysis and risk perception a long-term research priority in the early 1980s. It reasoned that the public's view on hazardous phenomena is in part "formed in a complex social setting in which risk issues may be only the latest arena of social and political power struggles, equity conflicts and other subtle social processes."[109]

An early study conducted with foundation monies started from the postulate that the perception a society has of risk is a social product, and that it is possible to understand why certain activities are perceived as risky when they are not, and vice versa. The authors, Douglas and Wildavsky, made the following analysis: modern technological risks, and nuclear power in particular, are opposed by strategically placed sectarian groups, the most important of which is the ecology movement. To ensure its survival, the sectarian group must maintain a sharply critical role; it will undermine its own bases should it concede that any improvements have been made to the technologies. In order to retain and enlarge their bases the groups must augment their demands and increase their attacks on the powerful. The public thus comes to perceive that risks are rising when in fact they are falling. Such a perception is seen as a precondition for the survival of the ecology movement.

But how, ask the writers, do the numerous sectarian groups that make up the ecology movement attract members and the funding neces-

sary to continue their unreal preachings? The core members of these groups, they explain, are agitators and many are products of the social movements of the late 1960s and early 1970s. They use modern technologies, especially computerized lists and mail-order membership, to contact cheaply both prospective and current members. Membership fees are low, and so is the degree of commitment solicited by the organization. The latter factor permits people with engagements in other areas to be attracted to the organization, and low fees ensure that economic barriers to mass membership are few. The substantial resources obtained are invested in publicity campaigns that sell the image of an increasingly dangerous world.

Douglas and Wildavsky seek to replace the images propagated by these radical scaremongers with ones favorable to these modern technologies, of which nuclear power is the most visible. They explain their view that modern societies must opt for such technologies, and in so doing the authors assume that the techniques currently used to manage them are safe ones. In their search to build favorable images, the perspectives of risk perception analysts who with industry backing seek to culturally manipulate public perceptions of risk are firmly rejected.[110] The authors' solution is a political one.

Public mistrust of dangerous industries has two objective bases: the secrecy and the perceived lack of public control that surrounds their operation. The authors believe that these industries merit public confidence, that they are trustworthy. They propose that these be controlled by "resilient institutions," ones emphasizing mutual trust, knowledge, and craft skills; in other words, ones that will give citizens discretionary power over the running of these technologies. Sharing in the political control of these institutions, citizens will no longer have an objective reason to mistrust them. In this way the political base of opposition to such technologies, which manifests itself culturally, will be undermined.

The assumptions and value positions underlying Douglas and Wildavsky's work have been subjected to severe criticism,[111] but this does not, I believe, undermine the merit of their proposed political solution.

Charles Perrow, in his book, *Normal Accidents*,[112] arrives at an alternative explanation for public fears, and he links these to perceptions of long-term risk potential and of capacities to control future risks. His starting point is the empirical analysis of various industries and of incidents occurring therein. A theory of these incidents is constructed and it is concluded that some industries present far greater risks than the calculations of experts would lead one to expect. The author goes so far as to propose that a particular theoretically defined set of activities be

abandoned—nuclear power production is one example—and that another set which includes gene splicing, be severely controlled.

One of Perrow's major concerns is to understand why the public considers such activities to be unsafe when, in the pre-Bhopal and Chernobyl context in which he wrote, no devastating accidents had yet occurred. The response developed has a number of parallels with Chapter 1 of this book where the penetration of safety standards into industrial society and the accompanying substitution of notions of truth and justice for those of fact and value are examined. The existence of two extreme forms of rationality is perceived: empirically, one is held by systemic safety engineers and related personnel and the other is held by the general public. The general public thinks and acts in terms of what is called "social and cultural rationality," which emphasizes social bonding and diversity and is qualitative and imprecise. The former group adheres to a form called "absolute rationality," which requires the quantification of all important aspects of a problem and the translation of reflection into a series of narrow and precise goals.[113] Public opinion polling studies are then used to investigate popular fears of "technological accidents," fears that the experts label as "irrational." It is found that these exist because the public reflects in terms of a model that is different from that used by the experts, and that this difference is the basis of its mistrust.

The reasoning from which this conclusion is drawn provides an important number of insights about differing reactions to risk, and because of this merits reproduction. In one study, experts and lay public were asked to estimate risks in some 30 activities; they produced similar estimates of high-risk activities, such as motorcycling or smoking, and low-risk activities, such as vaccination and home appliance use. Considerable variation was produced for other activities and reference is made to survey data to examine this phenomenon in depth. In certain highly specific circumstances the public overestimated risks compared with the experts. The public did so when it perceived that risks are increasing and cannot be readily lessened by technological mechanisms, that technology has the capacity to produce a large number of fatalities, that risks and benefits are inequitably distributed, and that risks are unknown, involuntary, unfamiliar, and uncontrollable. Such public perceptions of the technologies were found to be the "best predictor of perceived risks"; such risk has been called "dread risk." Experts do not use such considerations in their calculations; rather, they "used simple body counts or theoretical estimates of such counts."[114] In other words, the public does not trust the ability of risk managers to make good their claims, and it questions the systems they have created. Public reaction is

also a defense against the threat posed to certain liberal and democratic values that in Western nations have come to be treated as an integral part of the human condition: among these are equity, voluntary behavior, and control over external forces.

Thus, risks should be made manageable, their destructive potential reduced, use should be made only of materials with relatively known risks to humans, and production systems should become transparent. In Perrow's language: uncoupling, slowing down, and simplifying activities would reduce both accidents and the publicly experienced "dread" of them. Some technologies threaten the public in important ways, have few compensating benefits, and are based on production systems with high levels of built-in capacity for failure—nuclear power and weapons are two examples[115]—and these should be abandoned.

In spite of their major differences Perrow and Douglas and Wildavsky, united in their adherence to liberal and democratic values, agree on one important point: that the public's participation in decisions relating to dangerous industrial processes should be encouraged by making these better understood and more readily controllable. Such a view is quite different from that of most systemic safety engineers, risk perception analysts, and related groups. For them, the complexity of the issues involved and the irrationality of the public constitute barriers to participation in a domain that experts believe is purely technical. What is revealed here is a cultural and political conflict over the control of important decisions that potentially affect the whole society.

Risk Management: Building Trust, Stimulating Mistrust

Risk perception studies are carried out and psychologists work on the problem of how to change the nature of the public's fears in an effort to depoliticize the problem. Efforts are made to show the public "the facts": how systemic safety calculations have minimized risks. In so doing the aim is to demonstrate the irrelevance of public "values"—in the form of their fears—when faced with the technologies. However, it has been recently acknowledged that the idea that the programing of safety is possible has lost public support due to incidents such as Three Mile Island and furthermore that the public mistrusts company and government actions in areas that affect its safety.[116] From within its own walls, risk perception analysis has been seen as an attempt to legitimate political choices by turning them into technical problems.[117] Research into the area called "risk acceptance" moves in a new direction: it seeks to determine which forms of decision making meet with widest public support and to investigate methods of "public participation." It seeks to

redefine cultural conflicts as conflicts of interest and to then open up a negotiation process—labeled participation—to resolve such conflict. In this manner an attempt is made to increase the acceptability of risk.[118]

During the nineteenth century, accidents were treated in the private sphere between employer and worker, but as the misery of victims became visible, their compensation became subject to public dispute. Eventually laws were passed in the more advanced nations to guarantee minimum levels of income for victims and their families. Accidents were again removed from the public sphere, and their questioning confined within the boundaries of state-regulated compensation systems and, if need be, the judicial system. In the advanced Western nations accidents produced by work have once again become a public issue, but now the focus of much concern is for nonworker victims. Two important preoccupations rear their heads: the ability of firms to pay for loss and the increasing levels of damage claims.

It is in the United States that these preoccupations are most clearly evident. The $1.6 billion lawsuit for the loss of one astronaut in the Challenger accident adds to the wins of the Ford Pinto damages and medical malpractice suits. A domestic Bhopal or Chernobyl in the United States could threaten the economic survival not only of the largest corporations and the insurance industry, but also of the national economy.[119] In view of the increased prospect of major accidents that has accompanied the spread of high-risk technologies, it seems reasonable to hypothesize that a political solution, perhaps similar to that created with the generalization of workers compensation, will have to be produced. It would seem that a politically viable resolution in the area of compensation (it is interesting to note that Ewald, from a different basis, arrives at a similar conclusion) would be the removal of civil responsibility from individual firms or persons for accidents, and the creation of collective responsibility.[120] The New Zealand accident compensation legislation thus seems to fall into place as an inexpensive and precocious model adapted to a new age.

However, it is highly unlikely that even such a new concept of compensation would be sufficient to make these high-risk technologies publicly acceptable. This notion is grounded in the idea derived from theoretical reflection that a new culture is forming in the industrialized nations. Research evidence from the United States, the only country in which the question seems to have been examined in depth, is interpreted as backing up this idea. One of its elements is the notion that life is to be protected "at any price." Thus the public has demanded that they be given guarantees that risks can be managed. Systemic safety, in its various forms, seeks to be the tool to accomplish that. Paralleling the

fate of the Davy lamp, it has met with opposition from segments of the population that express their notions of truth and justice—those who experience dread risk. Systemic safety links up with risk communication, risk analysis, and public participation to limit public debate; such techniques add to the more traditional ones of company-sponsored murder,[121] public relations efforts,[122] and the hushing up of serious incidents as tools used in Western democracies with the aim of leading the public to accept risks.[123]

In nondemocratic and Third World countries, "solutions" to the unacceptable nature of these new types of work accident have been found. Simply put, in the former the public is denied access to information and the right to express and organize itself, and in the latter struggles for day-to-day survival simply overwhelm longer-term preoccupations.

Work safety in the Western democracies now appears to be subject to the pressure of a new actor. Loosely called "the public," it complicates the traditional triadic relationship between safety institutions, employers, and workers. This observation forces us to take a good look at this actor in an attempt to better understand its action, and to determine whether its action is limited only to questions concerning major accidents or whether it joins some wider set of concerns.

THE TRANSITION TOWARD A POSTINDUSTRIAL SOCIETY

"The Public": A New Social Actor?

From the end of the 1960s the quiet relationship between employers, workers, and state became a visibly unstable one. Can the accident-specific movements of this period be better understood against the background provided by a general theoretical interpretation of the events, from Nader's consumerism to Cohn-Bendit's form of radicalism, that rocked many Western societies during this same period? And, moving beyond this, do the rise of public "dread" and of systemic safety constitute localized phenomena or are they linked to a wider pattern of social change?

Alain Touraine's interpretation of France's 1968 May Movement is intimately related to his theory of postindustrial society. Touraine explains that French society became aware that decisions, even those based on the best technical studies, are always political. Such decisions support private interests—the interest of those who dominate the important centers of production and consumption activity. The May Movement is analyzed thus:

> Social conflict reappears in full light and opposes, on the one hand those who reduce social action to the adaptation to needed changes that are claimed to be founded on reason and, on the other hand, those who, to the contrary, demand a democratic power capable of controlling those centers which guarantee economic growth at the same time as the society's manipulation.[124]

The May Movement mobilized not only students, but technicians, scientists, teachers, and other groups of nonindustrial worker, groups previously excluded from large-scale social protest. Their demands contained elements foreign to normal industrial conflict and alien to existing political parties. An antitechnocratic actor was in formation.

Such an analysis permits us to locate the rupture as based not only in the traditional tensions within and between safety and compensation institutions, but also in the emergence of a new type of society and the new social actors it produces. The powerful act by investing in science, technology, and education, and through this they attempt to manage the society. When it plays its specific role, acting as an agent of this investment process, the technocracy conveys an image that it alone is capable of determining the rational organization and control necessary for "good living." Its power is inextricably linked to a quest for the monopolization of the means of producing and dealing with complexity. In a way similar to engineering in the past it denies the existence of social actors and their rationality, but different from engineering, its action is not confined to narrow parts of the productive sphere. It seeks to influence all aspects of production and consumption activity by investing to replace notions of truth and justice with ones presented as "facts." The whole of culture is subject to its penetration. It is a power that requires the production of new cultural bases to ensure survival, and the conferring of a supreme value to life falls into place as one such base.

These reflections lead to the development of a new perspective on dread risk, in which it can be interpreted as a form of collective consciousness spontaneously developed in opposition to technocratic control of specific industries. New social movements, such as the ecological groups examined by Douglas and Wildavsky, can be seen as issue-specific actors who contest the rise of this new power and the secrecy that surrounds its operation. Various groups of safety professionals both created and responded to new demands: some Italian medical professionals and the scientists that formed the British Association for Social Responsibility in Science constitute but two examples. Both specifically fight the secrecy that prohibits workers access to knowledge of the products and processes with which they labor.

Divided, firing at different targets. whether related to industrial safety or to wider issues of societal control, the various currents of

opposition to the technocracy have not yet achieved the status of a new social actor—an actor, perhaps analogous to the working class in industrial society, with a common forged identity combating a common adversary on a field that both protagonist and adversary share and recognize as being one in which control of societal development is fought.

The technocracy, as we have seen, combats emerging opposition by resorting to a number of strategies: risk perception analysis, denial of information, and public participation on the technocracy's terms constitute fragments of one strategy. This strategy is designed to create favorable perceptions, to suppress the unfavorable, and to politically integrate the forces of opposition into its project. A second strategy is to strengthen systemic safety, and a third is to abandon activities in those areas it proves unable to dominate, either technically or through altering public perceptions, but to continue its development in other areas. A failure of the first strategy implies the necessary recourse to the second in order to avoid the worst possible result: a strategic withdrawal from a particular area of social and economic life.

Systemic safety helped create and make possible industrial applications of certain technologies; as these become more common, public fears become more intense, and ironically this fuels further demand for systemic safety. In this context a key question becomes: can systemic safety eliminate industrial accidents and specifically those that by putting the general public at risk have been linked to the possible emergence of an antitechnocratic actor? Beyond simply examining the limitations of systemic safety the reply to this question demands construction of sociological analyses of accidents and reflections upon the action of social movements.

Accident Prevention and Systemic Safety

The manufacture of dangerous chemicals is widely cited as necessitating systemic safety practices. Analyses of two chemical accidents of earthshaking consequences, Seveso and Bhopal, show that in neither plant were practices close to what systemic safety aspires to in its theoretical and technical literature.

Seveso

The Seveso accident released dioxine, a substance more toxic to humans than strychnine, into the atmosphere. Fifteen days after its release the first evacuation measures were taken; over 700 persons were moved from their homes and nearly 30 women had their pregnancies

terminated.[125] The official accident inquiry showed that the initial project for the factory had been altered in such a way as to increase risks, that no automatic system existed to halt production in case of accident, and a small investment in a necessary safety device had not been made. Because of either rewards or command level work relations, numerous regulations and standard practices were disobeyed and no formal system had been developed to guarantee coordination at the organizational level.[126]

Bhopal

At Bhopal, methyl isocyanate leaked into the atmosphere killing at least 2,000 people and injuring about 100 times that number. The plant, a former industrial showpiece to the world, had fallen on hard economic times. Reports on the accident are of course not based on sociological analyses; nevertheless, they show that adherence to the standards and training demands initially set by Union Carbide's head office had declined and a managerial blind eye turned on dangers of plant operation. An investigation by the *New York Times* detailed a series of points that indicate that work in the plant was routinely managed through social relations with the capacity to produce accidents: the division of labor was narrow and coordination faulty, maintenance and training were inadequate, qualifications downgraded, sections understaffed, safety equipment had been shut down, and certain risks were accepted as normal.[127] Government scientists, activists, and journalists agreed that the accident occurred when an inadequately qualified team was put to work washing an inordinately complex set of pipelines; because certain safety devices were not in place, water accumulated where it was not supposed to. The water began to react with the methyl isocyanate, pressure rose, and a leak was noticed. The temperature controls were not working, and from the recommended 5° Celsius the temperature rose to 400° Celsius at which point the cement above the tanks cracked. The emergency tank was unable to be used. "Nothing that Union Carbide had devised for its Bhopal plant was capable of handling such a runaway reaction."[128]

Challenger

The two accidents occurred, an advocate of systemic safety might argue, precisely because management had strayed from the school's principles. The report of the *Presidential Commission on the Space Shuttle Challenger Accident* takes readers inside an organization that during the

Apollo program had created "an extensive and redundant safety program comprising interdependent safety, reliability and quality assurance functions . . . to discover any potential safety problems."[129]

By 1986 this program had become ineffective or, as vividly captured in a book title, a "prescription for disaster."[130] The report of the presidential commission headed by W. P. Rogers permits this accident to be analyzed sociologically. The astronauts died because their relationship to their work was managed by disorganization. In technical terms, a ruptured seal caused the accident. The problems with the seal had been known within various sectors of management for some time, but this knowledge was not transmitted to the astronauts and they paid the price for working with a danger that was unknown to them. In the eyes of the commission a series of factors, both internal and external, combined to produce disorganization, and these, too, are important for sociological analysis. Political pressures existed to make the shuttle cost-effective. These led to the setting of an ambitious schedule with the consequence that launch was prematurely transformed into a routine event. This routinization led to a streamlining of the organization to avoid delays, various review procedures were bypassed, problems were not communicated, and false understandings were produced and in the absence of appropriate checking procedures reproduced. An organizational culture developed that favored the repeated taking of a known risk in a variety of technically defined problem areas and specifically in the case of the O-ring seals, because they "got away with it last time."[131]

Thus, the formal reporting system simply "lost" potential major problems from view, tests and rectifications necessary to guarantee adequate operating knowledge and coordination of the organizational level were not carried out, and the shuttle was launched and relaunched. The commission expressed surprise at the absence of specialist safety and reliability staff from major launch decisions. From a sociological viewpoint, this exclusion, as was that of the astronauts, was compatible with the rewards level pressures on management for short-term profitability and rapid launches. Launching, recovery, checking, and reassembly prior to relaunch of the spacecraft were jobs managed by social relations that have already been identified as producers of accidents in other contexts. At the command level technicians working for one contractor stopped reporting accidental damage that occurred during shuttle handling procedures for fear of losing their jobs.[132] At the organizational level disorganization was produced in a number of ways: information about observed problems was not transmitted to appropriate authorities,[133] information was inadequately analyzed and reported,[134] problem-reporting systems were short-circuited,[135] to give just three

examples. The potential dangers of astronaut underqualification were also mentioned, which was a consequence of reductions in the training period. This last point, if we read the commission's recommendation, seems to have been associated with rewards level pressures on top management: "NASA must establish a flight rate that is consistent with its resources. A firm payload policy should be established. The policy should include rigorous controls on cargo manifest changes to limit the pressures such changes exert on schedules and crew training."[136]

In the short-run the management of work through this combination of organizational, command, and rewards levels relations can be said to have been effective for it allowed the goal of a relatively rapid launch program to be achieved. In the longer run, resorting to these relations, which in the report (reflecting the tradition dominant in accident research) are identified as technical difficulties (O-rings, reassembly, landing procedures, launch-pad design), almost inevitably, would have produced an accident. The social relations used to manage the space shuttle program, in spite of the rhetoric of systemic safety that seeks to "engineer out" such relations by turning the human into an engineered individual component, produce accidents. They do this just as surely as do the relations we have seen operate in British mines, French construction sites, or New Zealand factories.

Systemic Safety: From Self-promotion to Perverse Effects

The systemic safety purist may deny the validity of this argument, replying that the Challenger accident occurred only because safety had become subordinated to a "higher objective": profit. The U.S. president of the System Safety Society wrote, after having read the commission's report:

> "We have all witnessed the struggle to optimize design when cost, weight, performance and accident risk factors must be weighed and to some extent compromised in order to meet a higher objective. We have all felt the pressures of schedule. We have all been intoxicated by the sweet taste of success. We have all been frustrated by apathy and disinterest in perceived safety problems when things are going well. It's no fun being the single voice in the room whispering "no" when everyone's shouting "Go, Go, Go!" The purist recognizes social, economic and political limitations on safety but wishes that these disappear, "The eyes of the nation are upon us now. . . . We can use this opportunity to put system safety into the vocabularies of engineers, managers, operators, legislators, journalists, teachers and taxpayers. Let's make the most out of a bad situation."[137]

It seems quite probable that demand for systemic safety will increase in the wake of the Challenger accident, but system safety now

appears incapable of realizing its claim—the elimination of accidents. Indeed, the denial, inherent to systemic safety, of the importance of social relations in managing workers relationships to their jobs introduces new problems. Perverse effects, such as the undermining of workers' notions of truth and justice, the introduction of new types of accident, inequality, and ineffective investment effects, appear once again on the scene.

Many modern high-technology processes are conceived of in such a way as to be so complex, filled with unknowns, and closely interlinked both functionally and temporally that workers are unable to acquire the qualifications necessary to execute work safely, and management is unable to coordinate work to prevent widespread disorganization. The design of work processes has made it impossible for workers to construct adequate notions about the state of processes and the control of dangers, to build a model of "truth."

The 1975 Rasmussen report is a central point of reference for the systemic safety school and is frequently used by those who seek to sell the idea that nuclear power accidents are a close-to-impossible occurrence. The Nuclear Regulatory Commission in the United States has criticized the report for the simplistic treatment it gives to system accidents, a type of accident specific to complex systems. This type of accident, which we shall examine empirically, appears to be largely ignored in systemic safety literature. This led E. W. Hagen, an editor of the journal *Nuclear Safety,* to observe that accident specialists are busily working in an area that has not been shown to be the main problem, "the main problem being the very complexity of these systems."[138]

Charles Perrow makes a distinction between component failures and system accidents. Both types of accident start with component failures, but in system accidents, multiple failures occur which interact in ways unanticipated by system designers and by those trained to operate them, whereas in component failures, single or multiple failures are anticipated and comprehensible.[139] Perrow then uses this distinction to interpret the Three Mile Island incident: in one sequence of events, water flowed the wrong way and an unexpected accumulation of hydrogen caused the risk of explosion if pumps were used to extract the water. These were just two of the incidents among the "multiple failures [that] interacted in an incomprehensible manner" during the event.[140] As in the British coal mines of the 1800s, inequality arises between workplaces where technical causes of accidents are effectively combated by technical means and those where technically defined causes of accidents remain unchanged. Design and training policies might be applied to reduce accidents, and where appropriate will reduce risks of accidents associ-

ated with component failure; however, they are seen as largely irrelevant for reducing the risks of system accidents. Inequalities can be expected to develop between those locales traditionally subject to a predominance of risks of each type.

The Confédération Française du Travail's (CFDT) examination of the French nuclear industry, Perrow's account of Three Mile Island, and accounts of Chernobyl indicate the recurrent dangers of reliance on engineered safety.[141] At Chernobyl safety devices were shut off during an experiment designed to increase safety and at Three Mile Island safety devices did not function; both events constitute cases of the ineffective investment effect. In 1980 the Indian Point Number 2 reactor sprung a leak, river water seeped into the containment building, and eventually 100,000 gallons collected undetected: the moisture level indicators had been designed to detect hot but not cold water. This leak was only discovered through an operator error![142]

A mere 13 seconds after the beginning of a series of occurrences that would produce the Three Mile Island incident, there had been a "false signal causing the condensate pumps to fail, two valves for emergency cooling out of position and the indicator obscured, a PORV [pilot-operated relief valve] that failed to reseat, and a failed indicator of its position. The operators could have been aware of none of these."[143] In other words, the operators were denied the possibility of conducting an independent verification of what was occurring: they were denied—through the process of plant design—access to truth.

There is little wonder that in such a context an embryonic new accident effect can be observed: workers treated processes as though they were in one state when in fact they were in another; thus, new errors were introduced into the system. "They thought they were avoiding a LOCA [loss of coolant accident] when they were in one and were making it worse."[144]

Even after an accident has actually occurred, access to truth might prove difficult to obtain; thus, the consequences can be aggravated and new deaths and injuries produced. Control room staff were stranded without any capacity to understand what had occurred in the Chernobyl explosion. No available instruments were capable of giving measures considered credible, and visual information was not readily accessible. Two young trainees were sent out to manually lower the graphite bars into the reactor's core and thereby slow down the nuclear reaction already in progress. Upon reporting that the core no longer existed, a boss admonished, "you've understood nothing." Attempts to cool the core with water continued. At a nearby lake night fishermen, in the absence of evacuation measures, continued to absorb radiation as they watched

the fire rage. Hours later we were reminded of seventeenth-century Britain where the question of "who goes down on the rope" would have been raised in mines, and in being resolved would have led to the detection of lethal gases. Doubtless we shall continue to hear stories about the Chernobyl physicist and engineer, Sitnikov. Management sent him to inspect the state of the core. Eight-and-a-half hours after the explosion, and suffering what would prove to be a lethal dose of radiation, he reported back that the reactor had been destroyed. He, too, was ignored as management continued to cool the reactor with water.[145]

Industries built to systemic safety specifications rely on humans to run them, and humans have their work managed by social relations. This school ignores such relations in its calculations and is quick to blame human failure in all accidents. From Bhopal to Seveso to Challenger, examples are found of voluntary servitude, disorganization, underqualification, and authoritarianism being routinely used to manage workers' relationships to the dangers of their tasks. The sociological theory posits that management through such social relations produces accidents.

Prevention, Technocracy, and Workers

Some contest such a notion and argue that resort to command level safety management is sufficient to guarantee safety in such industries. Their argument is undermined by empirical evidence. The most rigid disciplinarian work organizations in the world are military ones. In this context one could hypothesize that the Soviet Union and the United States nuclear submarine programs, which resort to rigid preparation and discipline to guarantee performance in the case of nuclear war, would use such managerial techniques to protect their expensive, strategic, and dangerous vessels. However, neither nation's fleet has been immune to fires or sinking. Instead of contributing to increase risks by denying the relevance of social relations, this simple example highlights the necessity to arrive at a deeper understanding of their role in the workplace and particularly in complex work systems.

Conclusion

All industries in this examination of systemic safety are similar to others in at least one aspect: whenever workers develop a sense of truth and are knowledgeable of their task's dangers, they can decide to accept or reject them. These industries may differ in two important aspects from others: first, it may prove impossible for workers to develop no-

tions of truth, and second, accidents might entail exposing the public to grave perils.

What should be done about complex industries of the type herein examined? Once again Perrow provides some clear indications: he reasons that where the impossibility of worker access to truth coexists with catastrophic risks to the general public and low-cost alternatives (e.g., nuclear power and weapons), the industry should be abandoned. Where potential benefits and catastrophic potential are high (e.g., recombinant DNA technology), restrictive measures should be taken to ensure worker and public access to truth and to controls on work.[146]

The technocratic elite speaks as though it and it alone was the incarnation of reason and progress. It ignores policy recommendations of the type Perrow makes, and it ridicules popular conceptions of truth and justice, fears of disaster, and demands for socially transparent controls of technologies. Opposition places high costs—economic, political, and social—on the technocratic development of certain industrial processes and in so doing has been able to slow down the realization of some of the technocratic project. Technocratic power thus appears dominated by a question similar to that which dominated industrial capitalists at the beginning of industrial society. For the technocrats the question becomes one of whether they will find a copy of the old recipe: one that passes through the desocialization of work dangers—their production, compensation, and now, public fears of them—to provide a successful solution to one of their woes? Before addressing a reply the obvious must be recalled: history does not repeat itself. Advanced Western societies are both democratic and highly complex, information is widely disseminated within them, and citizens appear to place a greater value on life than their counterparts of last century.

Social movements may force the abandonment of nuclear energy, a symbol of the technocratic age. However, such abandonment can in no way be read as a signal that technocratic power has been mortally wounded; it will continue to penetrate all spheres of life in a variety of ways, and one mode of its penetration into the workplace will be systemic safety. Such penetration will, as we have seen, be able to reduce certain kinds of accidents and will be associated with ineffective investment, inequality, and new accident effects, and, in addition, workers' incapacity to develop notions of truth. Needless to say, most safety professionals associated with the school will continue to exclude any notion that accidents are produced socially.

In spite of the promises of systemic safety, accidents will continue to be a cause for social, political, and economic concern. Yet the stalemate that surrounds the three schools suggests that change is imperative.

Three Schools of Accident Prevention in Check

Writing in 1985, Wilson would conclude his study on the politics of occupational safety and health in Britain and the United States thus:

> Once it is admitted that the argument that every life is priceless cannot be sustained, there is clearly no defensible moral position on the optimal compromise to be made; attempts at cost-benefit analysis are unconvincing, not only morally but also from an economic point of view. It is perhaps understandable, therefore, that both British and American political [responses have] . . . failed to grapple with the issue of occupational health [and safety]. Their failure has interestingly different forms: pluralist deadlock in the USA and corporatist deadlock in Britain. The central fact of failure, however, is critical. It is surely a matter of concern that two radically different systems, Britain and the United States, should have been so ineffectual in grapping [sic] with the problem.[147]

Such an analysis perceives that the crisis is of a general nature. However, the author forecloses options in such a way that, in concluding his study, he invokes the necessity to reinforce regulatory standards. It seems to me that only when the failure of the three schools is envisaged as a part of a much wider picture can advances be made in new directions.

The deepening of the standards approach, especially through government regulations, represents a continuation of the Weberian solution to the Marxian notion of class conflict that industrial accidents helped make visible. The rise of the cost-benefit school is a response to the increasing price, both economic and social, of the Weberian solution—it seeks a solution determined by the rationality of the economic marketplace. Systemic safety, in its pure form, seeks to build a social rationality that bypasses the economically and politically grounded conflicts that underlie the other approaches; through its project of a total planning or programing of work processes, it aims to foster a favorable cultural orientation toward its enterprise.

We have seen that each of these schools reaches impasses in its capacity to prevent accidents, which raises questions about the possibilities of change. At the beginning of the 1970s, given the widespread existence of forces of rupture, the political prospects for the emergence of fundamental changes appeared favorable. Such forces could, in theory at least, have articulated a school to renew those disciplines and practices that were so deeply questioned during the rupture. However, these forces, while asking for greater worker participation, seem to have been more successful in obtaining a toughening or a reorganization of the standards approach. In France the social movements joined with some trade unions and both agitated for more regulatory coverage and

in favor of extended worker rights to control safety.[148] In Britain, traditional demands for legislative change were reinforced and unions were led to participate in tripartite standards setting. This decision-making process led to compromise solutions that in some quarters have been criticized as prejudicial to workers.[149] In those Scandinavian countries examined by Deutsch, standards are fixed in a tripartite manner and once set are subject to no further contest.[150] In the United States the main thrust of the COSH groups was to join with unions and with them to demand and support OSHA initiatives. However, the Reagan era resulted in a considerable weakening of OSHA's political support, the economic crisis led to a loss of influence on the part of unions and to their adoption of generally defensive strategies, and COSH groups were accordingly obliged to reevaluate their strategies and adapt to the new times.

However, some attempts are being made to rethink strategies in ways that break with the past. Duclos reports the emergence of a solid effort, particularly in United States university medical schools, to constitute alternative scientific bases on safety and health from which to attack the currently dominant ones[151]; a sociologically informed epidemiology appears to be one such base. Italian occupational health militants have attempted to develop an alternative conception of their discipline which they see as serving workers; in certain regions practices have now emerged that emphasize mobilization and knowledge as the key to a healthier workplace and appear to demote standards to a subsidiary role.[152] In spite of their novelty most of the reevaluations are observed to move in three distinct directions: seeking to place the calculations of standards on new bases, amplifying notions of benefits in cost-benefit analysis, and providing political support for the penetration of notions of systemic safety into competitive sectors. What we observe empirically in postrupture years is that the actors with the political capacity to provide support for a new school, one that would analyze accidents as social products, lack the prerequisite common intellectual base.

Toward a New School

Picking Up the Threads

The vast majority of the militants of the social movements have incorporated themselves into the three schools; what in the early 1970s would have appeared as a potential political base to a new school thus seems much less so today. However, some of those who participated in

the rupture have refused integration into the schools: the Australian worker's health centers[153] and doctors working outside of official networks in the United States[154] constitute two examples. The British Society for Social Responsibility in Science continues to play a critical role. Davis gives much more than a personal view when questioning the adoption of the principles of systemic safety, in British ergonomics, which he sees as reducing human freedom for action to a minimum.[155] Duclos's study on safety in postindustrial sectors in France and the United States reveals hidden expressions of opposition among French engineers.[156] Beyond actors such as these, potential social bases for a new school obviously are to be found among members of the three schools who share a politically derived critique of the dominant models.

The restrictions that can be formulated with respect to the actions of each of the three schools make the demands so forcefully expressed in the 1970s for "new visions" of the accident question relevant.[157] Such visions can be found among workers, employers, professionals, academic researchers, and in some intermediary institutions in the workplace. Among the holders of such visions potential bases of support for a new school are to be found.

From an analytical viewpoint, the challenge is to reflect on such developments and to trace the space, both social and intellectual, within which a school with a sociological perspective can develop. From a political viewpoint, the challenge is to locate those forces that could combine to support the emergence of such a school. It is against the background of the passage from an industrial to a postindustrial society, with the accompanying birth of new conflicts in the spheres of information, interests, and culture and of new social movements, that such political transformations are to be viewed.

Using the Sociological Theory of Accidents

In this book a theory has been structured and tested. The theory appears to have sufficient explanatory power to become one of a series of obligatory reference points for a new school of accident analysis and prevention. Within such a school the methods used would permit accidents to be seen as consequences of the functioning of social relations. On the basis of such analyses new categories of accident statistics would be developed and applied. Analysis of interventions planned in the name of prevention would attempt to understand both their potential for accident reduction and their capacity to produce perverse effects. Prevention efforts employed would be monitored and corrections made as necessary.

A sociological school would envisage the methods of analysis, the statistical classifications, and the approach to prevention in markedly different ways from those of the three competing schools. At this stage the approach to prevention suggested by sociological analysis appears sufficiently promising to be worth a "fair try."

Rupture, Institution Building, and Choice

However, it is not sufficient for a theory to be intellectually promising; for it to be translated into practice it must have political support. Some potential social bases of possible political support have already been identified: some employers, intermediary institutions in the workplace, "dissident" professionals, and activists. In addition, both the workers' movement, which operates politically through the trade union movement, and an antitechnocratic "public" can be envisaged as social bases capable of joining together to lend decisive political support for the emergence of a sociological school.

It is entirely reasonable to suppose that the social peace that had settled around the theme of industrial accidents in the 1980s eventually will be destroyed by a new rupture. An era of redefinition of practices—of analysis and prevention, of compensation and responsibility—will subsequently be opened. In any process of redefinition various elements from the present are assembled in accordance with existing knowledge, creativity, the action of social movements, political forces, and political compromises to create the future. From this perspective it is often an eye-opening experience to reflect on how the present might have been different had other decisions been taken in the past. Imagine if the social causes of accidents expressed in the Children's Employment Commission hearings had become the commonly accepted categories of cause, would not the history of prevention have been totally different? Imagine if British coal mine managements had given attention to accident prevention solely as a function of observed rates, then roof cave-ins would have received more attention and explosions less. A continuation of explosion accidents at the same (but declining) rate as roof cave-in deaths would have guaranteed public visibility of accidents for a longer period, and this in turn surely would have extended the duration of publicly expressed concern about the phenomenon, with consequences for legislation and the union movement. Workers in certain areas drafted and administered their own compensation schemes, and had this practice been fostered and spread throughout Britain, could not contemporary notions of adequate compensation, care, and responsibility be quite different?

In proposing this type of reflection I do not wish to deny the great importance to workers' welfare of the safety and compensation measures introduced. Factors such as the desocialization of accidents, the reduction of public concern, the removal of workers from an active role in caring for victims, and, in Ewald's words, the assignment of the employer as "the person responsible for guaranteeing the worker's safety"[158] had, as we have seen, certain pernicious long-term effects. An antirationalizer might even go so far as to argue that the path chosen would come to extract a heavier long-term toll in lives and suffering than would the choice of a path based on the models of the "autonomous workers" examined in Chapter 1. Such reflections are made not to lament the past but to remind us that societies choose their futures and that choices are made, not as a function of social rationality or economic efficiency, but as a function of social movements and political forces.

READJUSTING THE PRISM: ASSEMBLING POLITICAL FORCES AND INTELLECTUAL BASES

It is as though a prism has been placed in front of us and into it are drawn the rays emitted by the institutions that have structured the twentieth-century response to accidents. As it is adjusted, rays are refracted from it that will shine light on the twenty-first century.

In what remains of this chapter an attempt will be made to reflect on the questions of the political support for and the intellectual bases of a school that is sociological in its analysis. First, an image will be assembled of how workers, employers, intermediary institutions in the workplace, accident research, and union inaction figure in the political scene; this examination will be interspersed with other pertinent considerations. Subsequently, considerations of the relationship between sociological theory and new approaches to prevention and compensation will be addressed. Finally, the emergence of an intellectual base and a new political actor will be examined as potentially important elements in shaping future responses to industrial accidents.

Elements of the Political Scene

Workers

We have repeatedly seen that the bases of a confirmation of a sociological understanding of accidents, their causes and prevention, exist among workers. Among British builders at the turn of the century and

seven decades later in a New Zealand and a series of French construction sites, a certain pattern of explanation repeated itself. From the depths of the early English coal mines to the heights achieved by the United States' first astronauts, workers can be seen demanding control over their work. In accordance with their own conceptions of truth and justice, members of each category identified social relations to which they were subjected to be potential producers of accidents. In mines, factories, and construction sites, workers have sought to exercise autonomy and control in order to reduce the weight of what have been theorized as accident-producing social relations.

Employers

Some employers have reached the conclusion that the relations used to manage work under normal conditions may be counterproductive! Of late this has occurred in some complex industries where workers' primary production task involves the mastery of exceptional events; in this situation some employers have recognized that self-run work-teams constitute the most effective guarantee of efficient production. In *Beyond Mechanization,* Hirschorn has dedicated considerable effort to examining such practices. Reflecting on Three Mile Island and other nuclear reactor incidents he argued, "we must design jobs in such a way that workers can effectively control the controls, modifying them and regulating them to prevent failures and errors unanticipated by the engineers."[159] In the systems he proposes workers must be able to form an integrated vision of what goes on in their area and have the capacity to correct it. Workers need to be able "to understand the consequences of their control decisions." He develops his argument further, "new technologies . . . demand that we develop a culture of learning, an appreciation of emergent phenomena, an understanding of tacit knowledge, a feeling for interpersonal processes, and an appreciation of our organizational design choices."[160]

What Hirschorn calls "postindustrial work" is successfully managed when workers have the capacity to develop their own notions of truth and to act in accordance with them. From this perspective it becomes imperative that work be designed to guarantee that workers' ability to develop such notions is preserved.

After considering conventional industrial activities in Sweden, a discussion indicates that the quality of working life can be improved when workers assist management in certain investment decisions.[161] Such a viewpoint should stimulate management's component elements: engineers, accountants, industrial medical practitioners—to redefine

safety research methods so that plant design takes into account worker views.

Rinefort's cost-benefit study proposed human changes as being more cost-effective than engineering changes.[162] It seems as though a space is gradually opening up within management theory for the acceptance of some notions of accident production and prevention that are compatible with a sociological approach. In fact, on a day-to-day basis some managements unceasingly resort to prevention practices that give priority to the prevention of sociologically analyzable dangers. Historically, training has always been an important concern, and beyond this sectors of management can be found combating the roles of extended work, piece rates, disorganization, and authoritarianism in producing injuries. On occasion such efforts may bring management into conflict with workers who, for example, in pursuing financial interests apply for jobs for which they are inadequately qualified, arguing that they have sufficient skills to guarantee safe work performance.

An Interlude: Safety Education and Worker Notions of Truth

The above observation raises the question of the relationship between competing worldviews and notions of truth. It is a question that is absolutely crucial for safety management, safety professionals, the operation of intermediary institutions in the workplace, and, of course, for workers. By focusing on the area of education an analysis can be teased out.

To what extent does the idea that workers can be educated for safety contradict the idea, central to this book, that workers have a sense of truth and justice that guides them in the execution of work and that where oriented to act safely and capable of acting autonomously from domination by social relations at other levels they will build a safe workplace? "Truth" is a notion, we have seen, that is formed through experience in a social context; coupled with a sense of justice it constitutes a foundation of a cultural tradition. In times of rapid change, when experience with a process or of materials is limited, the chances of workers obtaining functionally adequate knowledge are diminished. Explanations of accident cause are considered valid only when they exhibit, consistent with a theoretical framework, both causal and meaning adequacy. Workers, through exposure to causally adequate explanations, may come to alter their meaning states, and alteration of meaning states is one of the aims of education.

"Safety," however, is an area surrounded by attempts to desocialize accident causes, to "educate" workers into accepting explanations that

lack causal adequacy, and to have them act in accordance with the thus-developed meaning states. The definition of accident causes as technical rather than social phenomena is one notable example; however, of all such attempts accident-proneness theory is the most blatant and universally applied. This theory has been demonstrated to be inadequate at a causal level, yet we find that certain workers accept it as true! In combating a vision such as this education that relies on causally adequate data can contribute to the development of a new and socially located sense of truth.

Social relations permeate the construction of worker visions of safety. Workers, for example, may reject protective devices that they feel are unjust and then create causally false notions which they construe as having truth value, thereby intellectually rationalizing their rejection. Miners have refused electric safety lamps and permissible explosives as unsafe,[163] and carpenters paid on piece rates might refuse saw guards alleging the same. In such cases education informed by causal data can help reconstitute senses of truth on new bases. However, this does not mean that causal data fed into an educational process take priority over worker notions of truth. On the contrary, for causal explanation to be considered adequate, it must, in the perspective developed in this book, be confirmed by reference to workers' meaning systems. The traditional "top-down" educational process is inverted by the logic of some recent studies where instead of accepting professionals' causal definitions of risk, researchers gather meaning data through interviewing workers; the results thereby obtained lend themselves to the construction of causal hypotheses.[164] Where causally adequate explanations are in contradiction with workers' meaning states, and such differences persist after efforts aimed at modifying either or both sets of explanation, the differences simply continue unresolved.

"Education" programs are often based on the assumption that one truth exists and are considered successful when this "truth" is accepted by workers. Such success frequently represents nothing less than the ideological submission of employees to management perspectives[165]; such a conception is vigorously opposed by the viewpoint presented here.

Intermediary Institutions in the Workplace

The systematic treatment of conflicts between workers and others who speak in the name of workplace safety has been facilitated by the growth of intermediary institutions. Safety representatives, safety committees, and in some places the right to refuse dangerous work have

increased markedly. This has occurred in postrupture years as a result of union pressures, managerial strategies, and legislation. Such change is read in many ways: as a sign of incremental workplace democratization, as a sign of union strength, or as an impediment to increased productivity. From the perspective developed here, such developments are important because they may provide social bases from which dominant views of safety can be questioned in the workplace and accidents accordingly reduced.

In a number of countries worker safety representatives, protected by statute, have existed since the 1800s, but only in their mining sectors. In spite of the long history of "workmen's inspectors," I have been unable to locate any studies that evaluate their role in questioning dominant views of safety or in reducing accidents.[166]

Safety committee formation was encouraged in the United States by insurance companies in the early part of this century in the hope that they would reduce accidents. Legal backing for forms of worker participation came, as discussed in chapter 2, from Mussolini and later Pétain's France. In the post-World War II years, the French altered legislation to make safety committees mandatory in certain establishments. 40 percent of firms regularly disobeyed the law.[167] In 1977, 30 years of legislation was celebrated, yet the effectiveness of the committees never appeared to have been studied.[168] In Britain the factory inspectorate had suggested the benefits of safety committees as early as 1913 and from 1964 the union movement demanded that they be made compulsory. Between 1967 and 1969 their numbers grew by 22 percent.[169] A 1977 law made safety representatives compulsory in certain workplaces, and in 1978 safety committees, previously voluntary, became widely compulsory.[170] In both the United States and New Zealand these committees spread on a voluntary basis, and in a number of other countries on a compulsory one.[171] Such reinforcement and growth was seen by some writers as marking the beginning of a new era: "workers taking into their own hands problems of safety and health will . . . [in France and Britain] constitute the real instrument for an effective preventive action in the firm."[172] Such a judgment impels further study of these intermediary institutions.

The marriage of safety committees and representatives with "right-to-refuse-work" legislation and agreements lends potentially powerful support to worker expressions. "Resistance to danger" has been a constant feature in this book: from witnesses to the Children's Employment Commission to engineers at Three Mile Island,[173] we learn that dismissal often awaits or is feared by those who practice it. In Canada's Saskatchewan province a pioneering 1973 law granted workers the "right to

refuse unusually dangerous work based on a belief in the risks rather than on imminent danger."[174] France took a similar path a decade later, and a number of other European countries have also adopted related legislation.[175] In the United States 21 percent of major collective agreements were reported in 1981 to have conferred this right.[176] Two United States court decisions indicate the judiciary's acceptance of employee participation and responsibility in both worker and public safety. In 1980 a unanimous Supreme Court decision endorsed the right to withdraw from work when one sensed oneself to be exposed to serious danger. A 1990 California court decision went even further: $45.3 million in damages was awarded to three engineers for their unjustified dismissal from the Lockheed Corporation because they "blew the whistle" on the safety of military aircraft.[177]

From the point of view of a sociological approach it is important to examine the insertion of these intermediary institutions in workplaces and in the work relations used to run them. There is a dire shortage of studies that permit such an analysis; however, this state of affairs should not deter some observations. First, employers may not accept such rights: for example, at General Motors in the United States representatives were seen as invading management prerogatives[178] and in Britain committees met with a level of voluntary acceptance that was low enough to lead to the passing of regulations to make them compulsory; only three in five French employers were obeying requirements for committees a quarter of a century after the enactment of legislation. Second, the presence of these intermediary institutions in the workplace provides no a priori guarantee of safety. Indicators on this point are provided by several sources: the legal backing given worker participation by a Fascist government eager to disorganize unions, the transformation of safety representatives or committees into agents of employer control over workers,[179] and research results that cast doubt on their effectiveness in reducing accidents.[180] In addition, the right to refuse dangerous work leaves the definition of "danger" open. From the viewpoint of truth developed here this is laudable; however, employers may seek to "educate" workers to accept their definitions, workers may use the right as leverage in an attempt to realize their nonsafety interests, and where less blunt tactics fail, employers may resort to authoritarianism to limit the exercise of this right and guarantee work performance. This series of negative observations is made to combat the triumphant discourses of those who mechanistically equate the expansion of intermediary institutions with increased safety. In giving a positive face to this skirmish, it becomes necessary to seek a sociological understanding of their expansion, conditions of insertion, and production of results. Through such

analysis an improved appreciation might be obtained of the limitations surrounding their action and of paths toward overcoming these.

Indeed, in the context of postrupture France, Anni Borzeix has sought to investigate the obstacles confronted by union delegates and safety committees in promoting improved working conditions and to reflect on how these might be overcome. Worker members of safety committees encounter difficulties in handling technical languages and using resources made available by law. Employers neutralize their initiatives at the same time as they create their own; worker representatives thus lose their established monopoly over demands for improvements. Employers, she argues, have moved into a space that was traditionally reserved for unionists, who are left without a program. In addition, workers may act in accordance with their interests in (say) more leisure time or higher wages in ways that union programs define as unsafe; the safety committee representative in such circumstances then becomes a potential enemy of the workers. To these difficulties are added those surrounding committee delegates, who having little time available and typically elected from the ranks of the more skilled workers become removed from the shop floor. Accordingly, delegates come to negotiate rather than to organize or support an open struggle, to denounce rather than to demonstrate, tending "to centralize, to standardize, to globalize both the forms and contents of action by fear—often justified—of the activism of a category or a sector."[181] In other words, the articulation of and imposition of worker ideas of safety based in their notions of truth and justice are hindered, which occurs not only because of such obvious factors as employer agenda setting, but because of the way in which members of intermediary institutions—delegates or committees—function.

The desire of some French unions that through the committee and delegate structures safety become one part of a radical questioning of work has been frustrated. Some authors construct models of forms of worker participation in order to identify the structural bases through which frustration over their ineffectiveness might be overcome.[182] Borzeix, however, takes a different tack and postulates that "a profound transformation of union practices . . . firstly passing through a sort of cultural revolution"[183] must take place in order to permit the transformation of these participative structures beyond their present role. Such a change depends, in turn, on the development of a new intellectual framework within which to interpret activity and on the political capacities to impose a new framework for action. Such a "revolution" would necessarily lead to the union movement's rejection of the parameters—set by the three schools—within the context of which the intermediary

institutions function. It would, in turn, lead to demands for new definitions of cause and responsibility, and eventually raise its sights to seek new bases for legislative and judicial treatment. From the point of view expressed in this book, a sociological conception of accident analysis and prevention could serve as the intellectual basis for such change, and the eventual adherence of a wide body of safety professionals could provide crucial political support to the development of a new framework. Such a conclusion thus links the long-term effectiveness of the action of intermediary institutions to both the reconceptualization of accident analysis and the implementation of a new approach to prevention.

Politics and Optimism

Industrial accidents are produced by social relations. This founding principle of a sociological approach must necessarily be translated into accident classifications, reports, legislation, research, and education programs. This is a precondition for the generalization of a sociologically grounded approach to prevention. In the prerupture period some professional groups were seen making analyses compatible with sociological perspectives. From the mid 1960s an effort was made in Italy to arrive at a political understanding of the causes of all forms of worker ill health. Medical records were reformulated, and their previous technical categories replaced by socially sensitive ones known as "workers' models."[184] In France, one group of ergonomists solicited union and worker input in defining the objects of its study. In the United States NASA management was urged by the Challenger crash inquiry to place astronauts, because of their unique practical knowledge, in management positions. In France a 1976 conference joined together unionists, doctors, judges, and inspectors who agreed on the need to perceive accidents in broadly social terms.[185] In 1979 the CFDT union tried to turn the state INRS research agency away from its technical orientations and toward a deeper study of accident causes, evaluation of statistics collected, and the production of widely comprehensible high-quality information[186] Across the Atlantic, Berman wrote in 1978 that "only in the last ten years has independent research, often with union support, begun systematically questioning the doctrines and practices of the 'compensation-safety apparatus.'"[187] Also in the United States, militant COSH groups spawned by the rupture received government monies from the New Horizons program to educate workers. The immediate effect can be hypothesized as one aimed at reducing disorganization and underqualification through worker-organized and -directed education. The president of the United Steelworkers of America saw this as having

"uncorked a bottle of knowledge on workplace hazards, and unleashed an educational process which has awakened workers to the dangers they confront on the job."[188] In Britain the training of safety representatives was seen as equipping the workforce with vital knowledge and even politically—in terms of an old working-class utopia—as a preparation "for when the factories belong to us."[189]

Politics and Pessimism

However, the utopian dreams seem to fall to dust; the production of social analyses and responses is a political issue. The spread of worker influence into the area of prevention has been opposed because it impinges on employer interests by violating traditional managerial autonomy in capital allocation decisions.[190] In the United States government funding of the COSH-run education programs was cut.[191] Research by Baldamus in Britain, Dassa in France, and Berman in the United States, which sought to introduce questioning of a sociological nature into the area of accidents, was subject to funding withdrawal, censorship, and boycott, respectively.[192] Beyond such naked opposition, powerful forces have operated in the postrupture years to integrate elements capable of critical reflection into the three schools. Swimming in a theoryless sea of opposition produced from the rupture, many critics opted to take the bait thrown them and participated in institutional reform.

Such an appraisal leads to the rather pessimistic conclusion that the possible political bases of support for a sociological school are on thin ground. The social bases have been disaggregated by a double process: through a combination of repression by capital and state bureaucracies and of integration into the schools, where the production and transmission of knowledge is concerned and in the case of workplace committees and representation, through the scandalous paralysis of the union movement.

Rather than treating accidents in a way similar to that in which life and liberty are treated in democratic societies—as nonnegotiable items—the union movement generally prefers that safety become a matter of give and take at a quantitatively oriented negotiating table. This serious allegation about the union movement affects not only individual workplaces but the whole field of analysis of prevention and compensation.

The natural political base to the workers' movement is the trade union movement; it is the logical force to exercise political pressure for social relations to be recognized as the producers of accidents. Instead, and this is worth reemphasizing, it generally negotiates safety and com-

pensation, life and death, as though they belonged to the institutional space in which conflicts of interest are fought over—as though they were wages and salaries. It treats standards, first aid training, accident report forms, and safety posters as though they were neutral technical instruments. However, demands for new approaches to research and the translation of results into practice are necessary bases to the intellectual development and consolidation of a sociological school. The union movement is a sufficiently powerful actor to impede the emergence of this school through its refusal to confront issues of worker responsibilities in accident production, its emphasis on the technical nature of safety and on negotiation.

Accident Research and Union Inaction

The areas are numerous where groups of scientists agree that new research directions should be followed but where such agreement does not translate into actual research programs. Cancer research is one case in point. Here "the predominance of established medicine has resulted in an almost complete neglect of epidemiological research and thereby of the preventive approach to combat cancer, although this is the goal of public health authorities."[193] It would appear that public health authorities lack the strong political allies necessary to successfully engage in a struggle over resource allocation with a cancer research establishment adept at promoting its own interests. Where could these authorities find political allies? One obvious area would be among potential victims. However, except for the potential victims of industrially produced cancers, these constitute a dispersed group perhaps only capable of establishing a fragile identity on the basis of their "potential" to one day become victims. The lack of a strong, defined external demand leaves research and action in the hands of the most powerful, and not the most socially rational, actors.

In the case of industrial accidents, however, potential victims are not dispersed. They work together and through their work can establish a strong identity. Many potential victims are members of an institution, a trade union, built to defend them. By some mechanism the experience that workers live, that accidents are the product of social relations, does not appear to be articulating into the union movement. For should such an articulation have occurred, unions would surely have brought their considerable power to bear, forcing research and preventive action to focus on social factors neglected by those approaches that dominate contemporary thought.

By what mechanism have the unions come to ignore the lived-out

reality of the work world as an inspiration for accident research agendas and preventive action? Unions of a certain ideological persuasion use accidents to denounce the capitalist system, while others adhere directly to employer models of safety. However, the more common approach is an institutionally oriented one. At the beginning of this century we saw that union demands relating to accidents faded away once compensation and prevention institutions were established. Such demands subsequently raised usually took the form of disputes conducted within institutional bounds: over standards and new laws, around the question of increased compensation payments, or simply the negotiation of danger monies. Each successful negotiation can be presented as a victory achieved by the union. At election time they can be treated as visible and quantitative signs of material improvement.

Those who experience accidents socially see them being treated in material terms. Those who perceive accidents using conceptions of truth and justice have such conceptions treated as "values" by those who claim to manage safety in accordance with "facts." The problem of social relations has been transformed into a problem to be solved by negotiation and administration. But such a transformation has produced a gap between workers and unions. One consequence of this gap was the rupture: workers struck not only against union hierarchies, wanting a higher priority to be accorded to safety, but also against the approaches used to manage safety—approaches formulated, whether actively or passively, with union support.

A New and Sociological School: A Final Glimpse

Prevention

Accidents are to be treated as a social phenomenon. From national statistics to company and union records, accidents are to be defined as products of social relations. As a function of such definitions, preventive action is to be undertaken. Professionals, instead of being oriented by economic criteria of the cost-benefit school, by the administrative-political criteria of the standards school, or by the organizational criteria embodied in the practices of the systemic safety school, will be oriented by social criteria. In other words, the space for and form of ergonomists, doctors, inspectors, engineers, and other professional interventions would be determined by reference to accident-producing social relations. Where the majority of accidents are produced by financial incentives, the role for such "technical" interventions would be small. Certain forms of disorganization or underqualification may emanate from the

incapacity of certain task structures to accommodate limitations on human performance; in such cases, disciplines like ergonomics, cognitive psychology, and medicine could each have analytical roles to play. New legal instruments would discriminate between different types of social relations. For example, the deliberate production of underqualification by employers would be distinguished from the routine offering of financial rewards when legal action aimed to prevent or punish accidents is taken. A new conception of inspector action would become necessary: workplace inspection in function of sociologically diagnosed accident causes would probably lead to a differentiation in treatments between strongly and nonunionized plants, and between complex and simple production processes. The judicial system would develop new criteria for evaluating employer and employee responsibility in accident production: accidents produced by authoritarianism would be subject to the procedures of criminal law, those produced by routine to civil law.

Compensation

The other side of the accident coin is compensation. I have made no attempt to engage in the necessary task of creating a sociological theory of compensation and have ignored the important question of rehabilitation, but I will hazard a few possible elements of an emergent system. It would be created around the idea that compensation should take into account victims' notions of truth and justice. Accident causes would be defined socially. Their compensation might favor rehabilitation and social solidarity with victims, and it might introduce notions of equity and responsibility. The gap between the huge damages received by a few "fortunate" victims of work accidents and the misery of others, whether direct or distant victims, whether living or members of future generations, would be closed in harmony with notions of justice. Different from the way this gap has been closed in New Zealand, responsibility would be attributed to those benefiting from accident-producing social relations. In such a view, those responsible for the production of accidents through the systematic use of relations considered particularly unjust—authoritarianism and voluntary servitude being two obvious examples—would merit severe pecuniary penalties. Certain categories of accident victim might be judged worthy of lesser compensation than others: for example, those whose accidents result from the working of excessive hours or financial incentives. Victim notions of truth and justice would in such a way unite considerations of responsibility, compensation, rehabilitation, care, and equity in a single approach.

Political and Intellectual Bases for a New School

Subsequent to the rupture, research and action on a sociological base was found wanting for two reasons. First, there lacked a sociological theory that could serve as a central point of reference around which professional groups and the union movement could reorient and develop their action. Second, there lacked political forces capable of stimulating the development of such a school. What are the chances in the future, with or without a new rupture, for the founding of a sociological school? The reply has two bases, one intellectual and the other political.

An Intellectual Base to a Sociological School

The reply relating to the intellectual base can be succinct. Even a cursory reading of the available literature leads us to understand that accident prevention continues to be in crisis. The to-and-fro of the postrupture years appear as mere swings of a pendulum. With each such swing the schools discover new limits to their own activities, and from a scientific point of view the necessity grows for members to search in new directions. Reflection on both industrial and postindustrial work in engineering,[194] medicine,[195] psychology,[196] and ergonomics[197] shows a series of openings in directions compatible with the development of sociological understandings. Some research from these disciplines lends itself, as was seen in Chapter 3, to sociological interpretation. It appears that the intellectual foundations of a school characterized by a new dialogue between the disciplines are being laid. Embryonic intellectual support for a sociological school of analysis appears to be on the horizon. In the world of ideas, in addition to that which it receives from outside, support also comes from within sociology. At a paradigmatic level this appears in an oblique fashion through the trailblazing work of Edgar Morin; from within a sociology of work recent Brazilian reflections are of utmost interest; and, finally, in the highly specialized area of the sociology of risk Rayner and Cantor, Short, Bogard, and others raise stimulating and relevant questions.[198]

The pace of development of such an approach does not depend only on factors endogenous to the intellectual world, it depends on an increase in external demand—and this is a political question.

"The Public": A New Political Actor Steps onto the Stage

My analysis of the postrupture period has essentially been that the forces of rupture split off into different schools and that the union move-

ment appears to be incapable or unwilling to struggle for a conception of accidents different from those currently available. Exceptions to this general picture exist and nothing impedes specific professional factions, safety committees and representatives, isolated workgroups and managements, or even cost-benefit school members from extending or reorienting present actions to place social relations at their center. However, the overall picture is one of little currently visible potential support from the ranks of traditional actors.

However, in recent years a new actor has appeared on the industrial safety scene in the advanced and democratic industrial nations. There are a good number of reasons to entertain the hypothesis that this actor will play a key role in any new rupture, thereby fueling demand for new approaches to accident analysis and prevention. Some analysts refer to this actor as "the public" and refer to its actions in banning nuclear power in Austria and Sweden and in halting the spread of this technology in the post-Three Mile Island United States. Public action has not sought to look inside the factories; it has simply sought bans. The various schools of prevention are reacting and trying to enlist its support for their enterprise: illustrating this, a recent U.S. survey showed a public preference for a systemic safety risk analysis approach over cost-benefit analysis.[199]

From a sociological viewpoint "the public" appears too nebulous a category to be considered as a social actor capable of influencing the politics of safety. We have seen that a public exists in the United States that resists certain types of development because it experiences "dread risk." This experience is produced among people who feel subjected to increasing, unknown, involuntary, unfamiliar, and uncontrollable risks that are capable of producing large numbers of fatalities and are shared unequally. The increase in dread risk has been interpreted as a reaction to the rise of technocratic power—that power linked to systemic safety. Those experiencing dread risk are thus interpreted as constituting but a segment of the antitechnocratic actor-in-formation: an actor that seeks to build a democratic power sufficiently strong to confront an adversary that is building its power on the basis of expertise, reinforced by tools of complexity and secrecy, a power that seeks to subject all aspects of consumption and production to its planning.

In recent years official investigations have allowed accidents to be seen in a new light. One can almost imagine that its rays are passing through filters similar to those of the British inquiries of the past. A landmark is Justice Mahon's socially perceptive (but politically premature and therefore shamefully overturned) report of the disorganized voyage of an Air New Zealand DC-10, in which flight coordinates had

been programmed so that on a clear day the plane would be flown straight into an (invisible) Antarctic volcano.[200] Seveso, Three Mile Island, Chernobyl, Bhopal, and Indian Point each seemed to reflect either the dying pangs of old or the birth of new forms of inquiry. But, for both its political success and its embryonic sociological insights, the report of the Presidential Commission into the Challenger explosion proved to be well worth waiting for. Thus accidents, while they may occur with less frequency, do so just as inevitably in modern industries using dangerous materials and sophisticated safety plans[201] as they do in the types of industry that produce the Courrières, Monongha, or Senghenydd tragedies. However, these modern industries are different from the old, not only because of their reliance on secrecy and complexity for their management, but because some have the capacity to impose destruction far greater and more widespread than their traditional counterparts. From dioxine manufacture to recombinant DNA research their numbers are increasing, there is little democratic control over their potential risks.

Could not a fresh Bhopal, Three Mile Island, or Chernobyl trigger off a new rupture? The *New York Times* analysis of Bhopal claimed that from an early stage the workers were aware of the fatal leak but that similar problems were typically "either fixed without examination or ignored."[202] The Three Mile Island inquiry, although beating the nearly dead horse of "operator error," showed the plant had been so designed as to make it impossible for workers to know about and quickly control crucial incidents. In both cases tens of thousands of lives were placed at risk. In democratic countries accident inquiries, although they frequently attribute accidents to operator error and promise ad hoc technical fixes to eliminate them in the future, often draw attention to the importance of phenomena in their production that are capable of being interpreted through a sociological theory of work.

The attribution of accident production to work relations at the rewards, command, and organizational levels by an antitechnocratic movement that contests industries with disaster potential emerges as one prong of a two-pronged movement. The other prong contests the processes by which major social and economic decisions are made. I will advance further in this exercise of futurology: the emergent movement will assert the implausibility of pretensions to produce total safety and, where "dangerous processes" exist, will stress the link between democratic control of work relations and safety. This will come to be demanded as a formal prerequisite for the execution of such work.

Out of such a movement the social basis for a new rupture may be born. Professionals, industrial workers, and union leaders seeing the continuities between social relations in advanced industries and in their

own, and hence a correspondence of prevention demands, may come to publicly break with dominant models. The basis of this anticipated split is likely to be a simple one: the reflection that the demands of an anti-technocratic movement for the management of industry with disaster potential should also be met in ordinary industry. In such a context, demand for a new mode of reflection and action around industrial accidents will, once again, open up.

Industrialists and states will not be slow to react to any such articulation. The former, mirroring practices of moving production from formal to informal sectors to escape laws, may engage in preemptive strikes moving dangerous industries to countries where "life at any price" is not a cultural value, democracy not the form of government, or anti-technocratic social movements judged to be nonexistent. States may reply by presenting popular attempts to control high technology as threats to "national survival." Safety professionals who remain integrated within the three schools are likely to become minor actors, resorting to the timeworn strategies of scapegoating and promising that such accidents will never happen again. Attempts, emanating from a variety of vested interests armed with appropriate "intellectual" support, will be made to submit emergent analyses to these schools.

Societies choose their futures. Self-knowledge and social action are key elements of such choice. By having constructed and tested a sociological theory of industrial accidents, I hope to have contributed some new self-knowledge. By examining elements of the history of action to prevent and compensate accidents, I hope to have produced an understanding of how choices of the past limit societies' capacities to act in the present and to take future actions. Since the beginning of industrialization, the question of accidents was just one of a series relating to social and economic development; today, just one single accident could eradicate all that development. In raising the specter of a terrible industrial disaster, in seeing it as a possible basis on which a new future will be constructed, and in constructing the sociological theory of accidents, I hope that social actors will become responsible for their own choices.

NOTES

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10. M. Bauer. 1982. Work accidents and their effect on the Czechoslovakian economy. *Journal of Occupational Accidents* 4:205–223 (p. 207).
11. G. Palmer. 1979. *Compensation for Incapacity*. Wellington: Oxford University Press.
12. Organization Internationale du Travail. 1985 *Analyse Comparative des Rapports des Missions Tripartites d'Evaluation de l'Efficacitè des Systémes d'Inspection du Travail dans Sept Pays d'Europe Occidentale: Republique Fédérale d'Allemagne, Belgique, Danemark, France, Italie, Norvege, Royaume-Uni*, p. 13. Geneva: Organisation Internationale du Travail. The number of inspectors in Italy dropped from 3,149 in 1973 to 2,565 in 1982.
13. Kelman, 1981, p. 82.
14. V. Navarro. 1983. The determinants of social policy a case study: Regulating health and safety at the workplace in Sweden. *International Journal of Health Services* 13(4):517–561.
15. G. Perkel and E. Frumin. 1980. Collective bargaining: Another approach to job safety and health, in United States Department of Labor, 1980, p. 259.
16. J. Lloyd. 1983. Health and safety at work could be threatened. *Financial Times* April 19. G. Assennato and V. Navarro. 1983. Workers' participation and control in Italy: The case of occupational medicine, in Navarro and Berman (eds.), 1983, pp. 152–167 (p. 166).
17. H. Makinen. 1982. Evaluation of the influence of regulation for presses. *Journal of Occupational Accidents* 4:177 (abstract of a paper in Finnish).
18. J. Wisniewski. 1983. *Les Accidents du Travail: Qui Paie Quoi?* p. 164. Paris: Les Editions d'Organisation.
19. S. A. Levitan, P. Carlson, and I. Shapiro. 1986. *Protecting American Workers*, pp. 119–120. Washington, DC: Bureau of National Affairs. R. S. Smith. 1979. The impact of OSHA inspections on manufacturing injury rates. *Journal of Human Resources* 14(2):145–170.

   G. K. Wilson. 1985. *The Politics of Safety and Health*, p. 4. Oxford: Oxford University Press.
20. Anon. 1986. *Occupational Safety and Health* 2(2):16.

21. Anon. 1987. Danger comes cheaper. *The Economist* November 14, p. 68.
22. W. T. Singleton. 1982. Accidents and the progress of technology. *Journal of Occupational Accidents* 4:91–102 (p. 98).
23. W. T. Singleton. 1983. Occupational safety and health systems: A three country comparison. *International Labour Review* 122(2):155–168 (p. 168).
24. N. A. Ashford. 1976. *Crisis in the Workplace*, p. 46. Cambridge: MIT Press.
25. W. Baldamus. 1979. Alienation, anomie and industrial accidents, in M. J. Wilson (ed.), 1979. *Social and Educational Research in Action*, pp. 104–140 (p. 105). London: Longman/Open University Press.
26. B. Solins. 1974. *Une Exploitation Intensive des Statistiques Nationales d'Accidents du Travail.* Aix: Laboratoire d'Économie et Sociologie du Travail. p. 235. B. Solins. 1976. Une exploitation des statistiques nationales des accidents du travail. *Revue Économique* 27(3):433–482. Y. Saillard and A. Serbert Samier. 1975. Une analyse sectorielle des accidents du travail. *Economie et Statistique* 73:67–74.
27. J. Kronick *et al.* 1978. *Community Responsibility: The New Zealand Accident Compensation Act as a Value Response to Technological Development*, pp. 250–251. Unpublished report funded by National Science Foundation. (Grant No.OSS 76-14794). I. K. Walker. 1981. *Occupational Safety: An Inquiry into the Coordination of Legislation on Industrial Health, Safety and Welfare.* Wellington: State Services Commission. For further information on New Zealand, especially pp. 125–127 where an increase in numbers of inspectors from one per 3,700 to one per 2,200 construction workers accompanies a slight reduction in accidents.
28. J. B. Gordon, A. Ackman, and M. L. Brooks. 1971. *Industrial Safety Statistics: A Re-examination*, p. 10. New York, Praeger.
29. Baldamus, 1979, p. 119.
30. P. Jardillier. 1965. *L'Organisation Humaine des Entreprises*, pp. 289–302. Paris: Presses Universitaires de France.
31. See: J. Irvine, I. Miles, and J. Evans (eds.). 1979. *Demystifying Social Statistics*, p. 232. London: Pluto.
32. Institute for Operational Research. 1972. *A Study of the Statistics Relating to Health and Safety at Work*, p. 41. London: Her Majesty's Stationery Office.
33. A. R. Hale and M. Hale. 1972. *A Review of the Industrial Accident Research Literature*, p. 81. London: Her Majesty's Stationery Office.
34. S. W. Malasky. 1974. *System Safety*, p. 310. New York: Hayden.
35. Baldamus, 1979, p. 111.
36. Personal correspondence of June 10, 1988 from M. J. J. Vogt, Director of Study and Research at the INRS research center at Vandoeuvre-Les-Nancy.
37. T. Dwyer (ed.). 1983. *The Industrial Accident Data Base.* Wellington: Department of Labour, lists 17 research papers having being compiled in the 1975–1980 period compared with 5 in the "prerupture" 1962–1967 period.
38. J. F. Short. 1984. The social fabric at risk: Toward the social transformation of risk analysis. *American Sociological Review* 49 (December): 711–725. Refers to Inhaber and Norman's finding that the number of Citation Index article titles containing "risk" in them grew twelvefold during the 1966–1982 period and as a fraction of total entries grew sixfold (p. 712).
39. C. Sinclair. 1972. *A Cost-Effectiveness Approach to Safety.* London: Her Majesty's Stationery Office.
40. L. Ellis. 1975. A review of research on efforts to promote occupational safety. *Journal of Safety Research* 7(4): 180–189 (pp. 186–187).
41. F. C. Rinefort. 1980. A new look at occupational safety: A cost-benefit analysis of selected Texas industries, in D. Petersen and J. Goodale. 1980. *Readings in Industrial*

Accident Prevention, pp. 36–48 (p. 36). New York: McGraw-Hill. (Originally published in 1970.)
42. Rinefort, 1980, pp. 47–48.
43. W. K. Viscusi. 1978. Labor market valuations of life and limb: Empirical evidence and policy implications. *Public Policy* 26(3):359–386 (pp. 368, 370).
44. R. Stephaneck and D. Donadi. 1981. Essai d'appréciation de la gravité subjective des accidents du travail. *Le Travail Humain* 44(2):241–250. M. W. Jones-Lee (ed.). 1982. *The Value of Life and Safety* Amsterdam: North-Holland Publishing. (Proceedings of a conference on the theme held by the "Geneva Association.")
45. Viscusi, 1978, p. 364.
46. R. S. Smith. 1974. The feasibility of an "injury tax" approach to occupational safety. *Law and Contemporary Problems* 38(4):730–744.
47. R. A. Olsen. 1973. Research implications of the Occupational Health and Safety Act of 1970: A report on a symposium. *Accident Analysis and Prevention* 5(1):67–76 (p. 70).
48. United States Department of Labor, 1980, p. 186.
49. D. J. Curran. 1984. Symbolic solutions for deadly dilemmas: An analysis of federal coal mine health and safety legislation. *International Journal of Health Services* 14(1):5–29 (pp. 17–18).
50. Rinefort, 1980, p. 47.
51. D. F. Jones. 1973. *Occupational Safety Programmes—Are They Worth It?* p. A2–11. Toronto: Ontario Ministry of Labour. (See also pp. A4-1–A4-6.)
52. D. M. Berman. 1978. *Death on the Job*, p. 62. New York: Monthly Review Press. Berman is discussing the costs of both industrial death and disease, but estimates that real wage losses are much higher than his $18.2 billion figure.
53. J. Carpentier. 1971. Ergonomie et sécurité. *Le Travail Humain* 34(1):117–126 (p. 125).
54. International Labour Office. 1973. *Labour Inspection: Purposes and Practice*. Geneva: International Labour Organisation. This report, in a manner similar to my treatment, does not consider differences in organizational structures as important.
55. J. M. Gleason and D. T. Barnum. 1978. Effectiveness of OSHA sanctions in influencing employer behavior: Single and multi-period decision models. *Accident Analysis and Prevention* 10(1):35–49 (p. 47).
56. Ashford, 1976, p. 19.
57. P. Salim. 1983. The robots are coming: And taking over the hazardous jobs nobody wants. *Professional Safety* 28(3):17–23 (p. 23).
58. D. MacGregor and P. Slovic. 1986. Perceived acceptability of risk analysis as a decision-making approach. *Risk Analysis* 6(2):245–256.
59. F. R. Sizemore. 1980. Management consideration of the legal aspects of unsafe products. *Hazard Prevention* 16(12):16–21 (p. 20).
60. J. Lederer. 1986. How far have we come? A look back at the leading edge of system safety 18 years ago. *Hazard Prevention* 22(3): 8–10 (p. 10). See also C. O. Miller. 1985. A comparison of military and civil approaches to aviation system safety. *Hazard Prevention* 21(3):29–34.
61. Sizemore, 1980, p. 21.
62. S. R. Concha. 1983. Editorial. *Hazard Prevention* 19(2):2.
63. Various authors. 1986. The first 75 years. *Professional Safety* Supplement, October:2.
64. V. de Keyser. 1984. Editorial. *Société d'Ergonomie de Langue Française–Bulletin de Liasion* 32:3–5. See also the letter to the former author by F. Guérin (pp. 5–6) in the same publication. There also exists a current within the discipline that appears favorable to notions of systemic safety.

65. Berman, 1978, p. 72.
66. D. Moyen, E. Quinot, and M. Heimfert. 1980. *Exploitation d'Analyses d'Accidents du Travail à des Fins de Prevention.* Paris: Institut National de Recherche et de Sécurité. (Notes scientifiques et techniques de l'INRS, No. 23).
67. D. Duclos. 1989 *La Peur et le Savoir,* p. 251. Paris: Decouverte. See also his treatment of engineers where he observes, referring to practices that were assuming a certain importance in the construction industry at the time I investigated it (and constituted one important basis of the differences observed in the previous chapter between French and New Zealand safety management): "the more the elements of a system are integrated the more safety moves forward" (p. 135).
68. S. Dawson, P. Willman, A. Clinton, and M. Bamford, 1988. *Safety at Work: The Limits of Self-Regulation,* p. 205. Cambridge: Cambridge University Press.
69. Anon. 1986. By-laws of the System Safety Society. *Hazard Prevention* 22(5):22–25 (p. 23).
70. Various authors, 1986, pp. 13–14.
71. Rinefort, 1980, p. 47.
72. J. S. Felton. 1976. 200 years of occupational medicine in the U.S. *Journal of Occupational Medicine* 18(12):809–817. The author advocates "strong cost-effective planking" for the discipline (p. 816).
73. de Keyser, 1984, p. 4, raises specific questions relating to the inclusion of criteria of profitability and productivity in ergonomics.
74. R. Wilson and E. Crouch. 1982. *Risk/Benefit Analysis.* Cambridge, MA: Ballinger.
75. Berman, 1978, pp. 104–105.
76. Juffe, 1980, p. 142. R. C. Clutterbuck. 1983. The state of industrial ill-health in the United Kingdom, in Navarro and Berman (eds.), 1983, pp. 141–151 (p. 146). Levitan *et al.,* 1986, pp. 26–31.
77. J. J. Sheehan. 1981. *Cost Benefit Analysis: A Technique Gone Awry.* Paper Presented at the Third Annual Park City Environmental Health Conference, Salt Lake City.
78. The French journal, *Médecine et Travail,* reflects these tensions; an example can be found in number 119, 1984, where the column "La Presse et Nous" sees the Industrial Doctors Association's general secretary replying to those who would wish to impose limited definitions on the role of the medical practitioner in industry. D. Nelkin. 1985. Ethical conflicts in occupational medicine, in D. Nelkin (ed.). 1985. *The Language of Risk,* pp. 135–153. Beverly Hills: Sage.
79. A. Gerwirth. 1982. *The Moral and Cultural Values That Determine Views of Health and Safety In the Workplace, the Moral Values: What Should Be?* p. 13. Unpublished paper prepared for the conference of the Labor Policy Institute. Washington, DC, on "The Environment of the Workplace and Human Values," May 20–22. J. K. M. Gevers. 1983. Worker participation in health and safety in the EEC: The role of representative institutions. *International Labour Review* 122(4):411–428. "Some labour unions seem to regard health as a moral absolute . . ." (p. 414).
80. C. Reasons, L. Ross, and C. Patterson. 1981. *Assault on the Worker: Occupational Safety and Health in Canada,* pp. 252–257. Toronto, Butterworths.
81. Juffe, 1980, p. 31.
82. W. Adams and H. J. Jaffe. 1972. *Too Little and Too Late.* p. 12. New York: Bureau of Applied Social Research, Columbia University. (Report on Contract No. 116 of National Commission of State Workmen's Compensation Laws.)
83. National Commission on State Workmen's Compensation Laws. 1972. *The Report of the National Commission on State Workmen's Compensation Laws.* Washington, DC: Government Printing Office.

84. Woodhouse Report. 1967. *Report of the Royal Commission of Inquiry, Compensation for Personal Injury in New Zealand.* Wellington: Government Printer.
85. Pearson Commission. 1978. *Report of the Royal Commission on Civil Liability and Compensation for Personal Injury.* London: Her Majesty's Stationery Office.
86. Juffe, 1980, p. 31–32.
87. F. Morgenstern. 1982. *Deterrence and Compensation: Legal Liability in Occupational Safety and Health,* p. 70. Geneva: International Labour Organisation.
88. Berman, 1978, pp. 71–73 and p. 240, where benefits are calculated as a percentage of covered payrolls.
89. Wilson, 1985, p. 4. During the 1970s "the number of states providing workers with compensation benefits equivalent to two-thirds or more of salary rose from twenty-three to forty-seven."
90. M. Brancoli. 1973. *The Financial Aspects of Insurance Against Employment Accidents,* p. 37. Geneva: International Social Security Association. (Paper prepared for the 18th General Assembly in Abjidan.)
91. Brancoli, 1973, p. 41.
92. P. R. Kaim-Caudle. 1973. *Comparative Social Policy and Social Security,* p. 97. London: Martin Robertson.
93. P. Shannon. 1982. Bureaucratic initiative in capitalist New Zealand: A case study of the Accident Compensation Act of 1972. *American Journal of Sociology* 88 (Suppl):S154–S175.
94. Kronick *et al.*, 1978, pp. 564–565.
95. Kronick *et al.*, 1978, p. 333.
96. Kronick *et al.*, 1978, pp. 310–311.
97. F. Ewald. 1981. Formation de la notion d'accident du travail *Sociologie du Travail* 23(1):3–13, treats an early French legal decision of 1841 in such terms.
98. The full implications of this shift, that all compensation funds be drawn from general taxation revenues, have not been drawn. See also F. Ewald. 1986. *L'État Providence,* pp. 417–427. Paris: Grasset, for an interesting reflection on responsibility and "technological" accidents.
99. M. A. Vojtecky and M. F. Smith. 1986. Program evaluation and health and safety training. *Journal of Safety Research* 17(2):57–63. On p. 62, they cite such costs as a reason for companies to rationalize their health and safety training by evaluation processes.
100. R. de Reamer. 1980. *Modern Safety and Health Technology,* pp. 20–22. New York: Wiley.
101. E. Bardach and R. A. Kagan (eds.). 1982. *Social Regulation: Strategies for Reform,* p. 254. San Francisco: Institute for Contemporary Studies.
102. J. O'Connell. 1987. Tort versus no-fault: Compensation and injury prevention. *Accident Analysis and Prevention* 19(1): 63–71 (p. 69). Bardach and Kagan (eds.), 1982, plot the reflex of this move in the rise in product safety functions in firms during the 1970s: in "nondivisionalized companies" the percentage rose from 26 at the beginning of the decade to 79 toward its end, comparable increases being observed in divisionalized companies (p. 291).
103. O'Connell, 1987. J. L. Croyle. 1978. Industrial accident liability policy of the early 20th century. *Journal of Legal Studies* 7(2):270–298, sees the introduction of no-fault statutes in these times when the costs to employers of common law damages are becoming significant as paralleling the early history of accident compensation.
104. P. Aries. 1974. *Western Attitudes Towards Death,* p. 100. Baltimore, MD: Johns Hopkins University Press. E. Morin. 1951. *L'Homme et la Mort.* Paris: Correa, states that death changes qualitatively with a rising life expectancy, the desire for immortality rises, and the struggle against accidents is seen as a struggle against an ugly death.

105. D. Mechanic. 1985. Physicians and patients in transition. *Hastings Center Report* 15(6):9–12.
106. Wilson and Crouch, 1982, p. 3, citing the Marsh and McLennan Companies.
107. Wilson and Crouch, 1982, pp. 3–4.
108. Duclos, 1989, p. 249. An earlier date than 1981, which Duclos gives for the United States, is used.
109. Russell Sage Foundation. (n.d.). *The Russell Sage Foundation: 1980 and 1981*, p. 17. New York: Russell Sage Foundation. C. Eastman. 1910. *Work Accidents and the Law.* New York: Russell Sage Foundation.
110. M. Douglas and A. Wildavsky. 1982. *Risk and Culture*, pp. 83–101. Berkeley and Los Angeles: University of California Press.
111. G. H. Daniels. 1983. Review of M. Douglas and A. Wildavsky. 1982. *The Annals of the American Academy of Political and Social Science* May, pp. 237–238.
112. C. Perrow. 1984. *Normal Accidents.* New York: Basic Books.
113. Perrow, 1984, pp. 315–324. Perrow also treats a third type of rationality, "bounded rationality," that is not considered important for this discussion.
114. Perrow, 1984, p. 328.
115. Perrow, 1984, chapters 1, 2, 8, and 9.
116. R. E. Kasperson. 1986. Six propositions on public participation and their relevance for risk communication. *Risk Analysis* 6(3):275–281.
117. H. Otway and K. Thomas. 1982. Reflections on risk perception and policy. *Risk Analysis* 2(2):69–82.
118. Kasperson, 1986. For different versions, see J. M. Doderlein. 1983. Understanding risk management. *Risk Analysis* 3(1):17–21. H. Otway. 1987. Experts, risk communication, and democracy. *Risk Analysis* 7(2): 125–129.
119. The United States economy has been cushioned against liability suits in case of a nuclear accident by a law that limits these. Other sectors do not benefit from similar protection.
120. See note 103. See also Ewald, 1986, pp. 417–427.
121. J. R. Green. 1980. *The World of the Worker—Labor in Twentieth Century America*, pp. 244–245. New York: Hill and Wang. A famous case is portrayed in the 1983 film *Silkwood*, directed by Mike Nichols, Fox.
122. P. Stevenson. 1990. Hill and Molton's big PR problem: An interview with Robert Dilenschneider. *Manhattan Ink*, July, pp. 61–68. It is claimed that had a different public relations approach been used, "Three Mile Island wouldn't be etched into the public mind." B. Yagoda. 1990. Cleaning up a dirty image. *Business Month* 135(4):48–51.
123. P. Lagadec. 1981. *La Civilisation du Risque*, pp. 218–219. Paris: Seuil, treats the French state's systematic resort to secrecy to limit public knowledge about the operation of high-risk technologies.
124. A. Touraine. 1968. *Le Communisme Utopique*, p. 280. Paris: Seuil.
125. G. Cerruti, S. Zedda, L. Conti, C. Caderna *et al.* 1977. *Survivre à Seveso?* Grenoble: Maspero and Presses Universitaires de Grenoble.
126. Lagadec, 1981, pp. 37, 39.
127. *New York Times* 1985, January 28, pp. A1ff., January 30, pp. A1ff., January 31, pp. A1ff. and February 3, pp. A1ff.
128. S. Hazarika. 1987. *Bhopal: The Lessons of a Tragedy*, pp. 66–68. New Delhi: Penguin.
129. W. P. Rogers (Chairman). 1986. *Report of the Presidential Commission on the Space Shuttle Challenger Accident*, p. 152. Washington, DC: Presidential Commission.
130. J. J. Trento. 1987. *Prescription for Disaster: From the Glory of Apollo to the Betrayal of the Shuttle.* New York: Crown.

131. Rogers, 1986, p. 148. H. S. Schwartz. 1987. On the psychodynamics of organizational disaster: The case of the space shuttle challenger. *Columbia Journal of World Business* 22(1):59–67, develops a different explanation; using psychological categories he builds an interpretation that is located in the development of narcissistic existential dilemma within NASA. "Why we should have come to think that we could solve such problems through technology or through organization is a question that goes to the root of the tragedy that we have found." p. 67.
132. Rogers, 1986, p. 194.
133. Rogers, 1986, p. 141.
134. Rogers, 1986, p. 159.
135. Rogers, 1986, pp. 154, 193.
136. Rogers, 1986. p. 201.
137. T. K. Pethe. 1986. Message from the President. *Hazard Prevention* 22(4):2.
138. E. W. Hagen. 1980. Common mode/common cause failure: A review. *Nuclear Safety* 21(2):184–192.
139. Perrow, 1984, pp. 70–71.
140. Perrow, 1984, p. 31.
141. Syndicat CFDT de l'Energie Atomique. 1975. *L'Electronucléaire en France.* Paris: Seuil. G. Medvedev. 1990. *La Vérité sur Tchernobyl.* Paris: Albin Michel. N. Hawkes *et al.* 1986. *Chernobyl: O Fim do Sonho Nuclear,* pp. 77–87. Rio de Janeiro: Jose Olympio.
142. Perrow, 1984, p. 45.
143. Perrow, 1984, pp. 21–22.
144. Perrow, 1984, p. 26.
145. Medvedev, 1990, pp. 118–144.
146. Perrow, 1984, pp. 342–352.
147. Wilson, 1985, p. 169.
148. D. Duclos. 1984. *La santé et le travail,* pp. 74–86. Paris: Decouverte.
149. Anon. 1981. *Hazards Bulletin* 25:3. (Commentary on the new British lead regulations and code of practice.)
150. Deutsch, 1981, p. 130.
151. D. Duclos. 1984. La santé au travail comme théme d'action militante: l'Expèrience des groupes C.O.S.H. aux États-Unis. *Sociologie du Travail* 2:177–194.
152. Assennato and Navarro, 1983, p. 166, have seen this movement to be more pro-labor than pro-management, but having in recent times lost some of their original emphasis on giving priority to workers' versions and analyses of their illnesses. Martignani and Biocca, 1990, analyze the recent efforts of this movement in a more optimistic frame.
153. B. Bartlett *et al.* 1979. The politics of occupational health. *New Doctor* 13:12–18.
154. L. Rosenstock and N. H. Heyer. 1982. Emergence of occupational medical services outside the workplace. *American Journal of Industrial Medicine* 3:217–223.
155. P. R. Davis. 1983. Ergonomics in the United Kingdom: Another crossroads. *Ergonomics* 26(2):121–122.
156. Duclos, 1989, pp. 107–135.
157. Hale and Hale, 1972, p. 81. T. Nichols. 1975. The sociology of accidents and the social production of industrial injury, in G. Esland *et al.* 1975. *People and Work,* pp. 217–229. Edinburgh and Milton Keynes: Holmes McDougal, and Open University Press.
158. Ewald, 1981, p. 13.
159. L. Hirschorn. 1984. *Beyond Mechanization: Work and Technology in a Postindustrial Age,* p. 158. Cambridge: MIT Press.
160. Hirschorn, 1984, pp. 162, 169.

161. B. Gardell and G. Johansson (eds.). 1981. *Working Life: A Social Science Contribution to Work Reform*, pp. 7, 63. Chichester: Wiley. See also Agence Nationale pour l'Amélioration des Conditions de Travail. 1983. *L'Apport des Salaries a la Securite*, No. 74. Paris: Lettre d'information de l'Agence Nationale pour l'Amélioration des Conditions du Travail, and Hirschorn, 1984, pp. 152–169.
162. Rinefort, 1980, pp. 47–48.
163. W. Graebner. 1976. *Coal Mining Safety in the Progressive Period*, pp. 135–137. Lexington: University Press of Kentucky, comments on worker actions in the early part of this century.
164. Those referring to workers representations do not normally venture so far as to develop complete theoretical models of cause, rather they stop at drawing insights. Theoretical work in the field of industrial safety (and the frequently interrelated area of health) remains sparse. For examples, see D. Nelkin and M. Brown (eds.). 1984. *Workers at Risk: Voices from the Workplace*. Chicago: University of Chicago Press; D. Duclos. 1987. La construction sociale du risque: Le cas des ouvriers de la chimie face aux dangers industriels. *Revue Francaise de Sociologie* 28:17–42; and V. de Keyser. 1982. La politique du regard. *Le Travail Humain* 45(1):117–124. In the area of safety management an example of a similar procedure (with a different bent) can be found in J. B. Revelle and L. Boulton. 1981. Worker attitudes and perceptions of safety. *Professional Safety* 26(12): 28–34. (See also Part 2 of the same article in *Professional Safety* 27(1):20–25.)
165. The word "frequently" is used because employers do not have the monopoly over claims to be the sole proprietors of truth. In my French construction research, some workers rejected as "political" the treatment to safety that was given by the communist CGT trade union.
166. E.g., R. Petre. 1968. Workers' labour inspection delegates in Belgium with particular reference to mining. *International Labour Review* 97(5):429–445.
167. G. Roustang. 1983. Worker participation in occupational safety and health matters in France. *International Labour Review* 122(2):169–182.
168. Anon. 1977. 1947–1977 Les comités d'hygiène et de sécurité ont 30 ans. *Travail et Securite* September, pp. 404–412.
169. M. Rezeau and F. Baque. 1975. La participation des travailleurs a la securite dans les entreprises en France et en Grande-Bretagne. *Revue Française des Affaires Sociales* 29 (October–December):29–48 (p. 48).
170. P. B. Beaumont and J. W. Leopold. 1982. A failure of voluntarism: The case of joint health and safety committees in Britain. *New Zealand Journal of Industrial Relations* 7(2):61–75.
171. United States Department of Labor, 1980, pp. 248–249. In 1971, 22 percent and in 1974–75, 42 percent of United States labor contracts with health and safety provisions called for joint union-management committees. Gevers, 1983, discusses an important increase in EEC countries.
172. Rezeau and Baque, 1975, p. 43.
173. R. D. Lyons. 1983. Crews at reactor criticize cleanup. *New York Times* March 28, cited in Perrow, 1984, p. 30.
174. R. Sass. 1982. Safety and self-respect. *Policy Options* July–August, pp. 50–52.
175. Roustang, 1983, p. 171. J.-Y. Labayle-Couhat. 1984. Droit du retrait: La France est-elle en avance? *Cahiers des Comités de Prevention du Bâtiment et des Travaux Publics* 2:8–12 Sweden in 1974, Norway in 1977, Holland in 1980 (pp. 8–9).
176. C. Gersuny. 1981. *Work Hazards and Industrial Conflict*, p. 123. Hanover, NH: University Press of New England.

177. Labayle-Couhat, 1984, p. 9. R. Vartabedian. 1990. Lockheed ordered to pay $45 million in firing 3. *Los Angeles Times,* November 16, pp. A1ff.
178. L. S. Bacow. 1980. *Bargaining for Job Safety and Health,* p. 65. Cambridge: MIT Press.
179. S. Dassa and P. Maclouf. 1975. *Contribution a l'Étude de l'Organisation de la Sécurité dans l'Entreprise.* Paris: Institut National de Recherche et de Sécurité. (Les notes scientifiques et techniques de l'INRS 3.) R. Lenoir. 1980. La notion de l'accident du travail: Enjeu de luttes. *Actes de la Recherche en Sciences Sociales* 32–33:77–88 (pp. 82–84).
180. Y. Shafai-Sahrai. 1973. *Determinants of Occupational Injury Experience.* East Lansing: Michigan State University, for a highly controlled study. P. B. Beaumont, J. R. Coyle, J. W. Leopold, and T. E. Schuller. 1982. *The Determinants of Effective Joint Health and Safety Committees.* Glasgow: Centre for Research in Industrial Democracy and Participation, University of Glasgow. Like other studies this ignores effects on accident rates.
181. A. Borzeix. 1980. *Syndicalisme et Organisation du Travail,* p. 367. Paris: Centre National des Arts et Metiers.
182. M. Simard *et al.* 1985. *Les Facteurs d'Efficacité dans l'Organisation de la Prévention des Accidents du Travail.* Montreal: Groupe de recherches sur les aspects sociaux de la prévention en santé et sécurité du travail—Université de Montreal (unpublished report: July).
183. Borzeix, 1980, p. 356.
184. A. Milanaccio and L. Ricolfi. 1976. *Lotte Operaie e Ambiente di Lavoro: Mirafiori 1968–1974.* Turin: Guilio Einaudi.
185. B. Elie. 1976. Un colloque sur les accidents du travail. *Le Monde* January 3, p. 12.
186. Juffe, 1980, pp. 151–152.
187. Berman, 1978, p. 5.
188. K. Calavita. 1983. The demise of the Occupational Health and Safety Administration: A case study in symbolic action. *Social Problems* 30(4):437–448 (p. 444).
189. Anon. 1981. Safety reps—A training for when factories belong to us. *Hazards Bulletin* 27:3.
190. Bacow, 1980, p. 93.
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Afterword

Weber and Saint-Simon observed the significance of expertise and scientific knowledge for modern organizations, and in so doing they perceived how these profoundly affected the character of modern society as a whole. However, another side to modernization has always existed: it can be perceived in the failures of bureaucracy, rationalization, market capitalism, and state socialism, through employing scientific and technical knowledge, to produce a society that could be considered educated, healthy, just, and free. Further "development," and the accompanying extension of rationalization, have been ceaselessly represented as capable of ensuring that solutions could eventually be found to all major social problems. Belief in such a utopian representation is on the decline in many modernized societies. From Chernobyl to Challenger, from the perceived failures of educational systems to educate and of hospitals to heal, the model crumbles.

In this afterword, departing from the basic insight that accidents are a metaphor for other "problems" produced in the workplaces of modern societies, I shall extend my reflections to the educational and health systems. In opening this reflection, rationalization will appear to be alive and well; however, as the discussion progresses, perverse effects are discovered and it is suggested that these require sociological analysis. Before outlining elements of a sociology of medical error and school failure, and the limitations that surround any attempt to compare such phenomena too closely with accidents, I shall make some specific observations on the operation of the spheres of information, interests, and culture. The emergence of a variety of alternative responses—intellectual, political, and social—some of which are multidisciplinary and integrate sociologically compatible insights, is then discussed. This reflection closes by suggesting that sociology has a role, by reconstituting

images of society and of social action, to provide maps for the future.

This afterword is underlain by a perception that social actors remain prisoners of the maps inherited from the past and constantly turn to them for guidance. They are lost. Thus, not only institutions but also whole societies come to define themselves as being in a state of permanent crisis. From the viewpoint of a sociology of postindustrial society, such definition reflects an incapacity to act in a new world that is in formation.

RATIONALIZATION AND ITS OFFSHOOTS

In contrast to this postindustrial society view is one that can be characterized as "hyperrationalizing." In one form it enters into the area of industrial safety as cost-benefit analysis. Hyperrationalism is also reflected very strongly in the utilitarianism of modern economics, in its "rational choice" variants within sociological and political theory, and in a variety of Marxist or critical approaches.

The crisis of the system, as presently constructed, is seen to be due to its irrationality. Representatives of particular rationalities set out to create specialist responses to eliminate the "irrational" element; to submit, for example, the organization's functioning to their design. The most global of these approaches argues that societies, institutions, and organizations are structured so that the rich receive better health care than the poor, the rate of school dropouts is inversely proportional to social class, and workers fall victims of accidents more than their bosses. In such a view the system itself is subject to critique for its irrationality, and for some it must be overthrown. For a cost-benefit approach, one promoted under diverse forms by neoliberal governments, differential outcomes are the result of "choices." However, "imperfections" are also seen to exist due to unwarranted interference in the functioning of the marketplace, and these must be eliminated to guarantee that all outcomes can reflect "rational choices."

Alternate views also exist, and the standards and systemic safety schools were seen to embody different approaches to industrial safety. Each urges the adoption of criteria of rationality that reflect the interests and worldview it promotes.

The perception that proposed solutions have failed, whether global ones that see the basis of the construction of a rational society in communist development or ones located within the confines of individual organizations lead to demands for change. Such demands may request

that rationalization be put on an alternate basis to serve new interests, or alternatively they may demand ever more specialized extensions of the techniques embodied in current approaches.

Organizations in modern societies, as we saw in Chapter 6 where systemic safety constituted an example, are increasingly subjected to investments that are postindustrial in nature. Information processing and sophisticated drugs and equipment come to dominate many aspects of medical facilities, and specialist safety departments are added to administrative functions. Schools emphasize the certification of teachers, modernized curricula, standardized tests, and the use of computers in efforts to improve their internal functioning and measures of the academic success of pupils. Aharoni articulates the principles behind this latter-day enlightenment when he says: "Of course, as we learn more about human motivation and behavior we may find out how to end the imperfections of humans and solve the social problems that grow out of them."[1]

The rationalizing response, however, has other faces. Many approaches to accidents examined in this book would come to classify all that could not be controlled in organizations as "error," as "irrational." Thus, "imperfect human elements" would be marginalized and defined as nonactors. Through such processes victims are blamed, union organizers crushed in the name of discipline, students' incapacities transformed into medical problems, and patients' refusals to submit to surgery seen as requiring psychological counseling. Specialized disciplines and professions emerge, ones that deal with the products of organizational error.

An alternative approach to error emphasizes the mobilization or participation of organizational members. Thus, safety committees are set up in the name of accident reduction. Quality circles spread from Japan in an effort to eliminate industrial waste and eventually expanded beyond industry to find a niche in hospitals where they monitor patient safety. Channels of consultation were opened to ensure that parents participate in the progress of their children through school. In the United States such strategies have been greeted with suspicion, being seen as a ruse whereby doctors, for example, retain their power and coopt patients in an effort to avoid possible malpractice suits. In such a perspective, mobilization or participation are seen as the latest in a series of attempts to rationalize and dominate the lives of subordinate actors. However, considerable research and theoretical development is necessary to understand under what circumstances these strategies represent such an extension or, alternatively, contribute to undermining

those models of organization and society which confuse this extension with progress.[2]

From Rationalization and Its Offshoots to Perverse Effects

It has been suggested that interventions designed to prevent organizational error and to treat its consequences share common roots with those that deal with accidents. It should come as little surprise to discover, in both the areas of health and education, that such interventions are associated with the production of perverse effects. Brazilian research finds that the activity of psychological services complicates the task of teachers and reduces learning,[3] and French research shows that instead of diminishing the inequalities between pupils measured on entry into the school these increase through the operation of the school system.[4] In medicine the concept of iatrogenic disease reflects the fact that medical interventions produce new illnesses.[5] The destruction of subordinate actors' notions of truth and justice is a theme present in the critical health and educational literature.

The links between perverse effects such as these and social relations, and in particular relations conceptualized through a sociology of error production, require specification.

TOWARD A SOCIOLOGICAL APPROACH

Information, Interests, and Culture

A part of the success in modern medicine can be attributed to its increasing capacity to acquire information about the biological, chemical, and physical worlds, and to transform this to cure. The inadequacy of information-gathering and processing practices and the strength of interests combined in the thalidomide tragedy, a tragedy that must rate as the Monongha of contemporary medicine. The notions of interest held by specific actors and the standards of information acquisition necessary to market drugs were modified by the ensuing lawsuits and regulatory action.

Information may, however, be ignored, and damaging practices continue for reasons that relate to culture and to the interests of powerful actors. The emphasis on radical mastectomy in the United States as a rational procedure to eradicate breast cancer and the ignoring of the damage it inflicts on a woman's identity contrasts with the less radical

procedures used in France. The latter are known to be about as safe as the former procedures and are far less damaging to female identities.[6] Nancy Reagan, the first lady of the "War on Drugs," was transformed into a national heroine and "role model," one with the "right stuff," in a media campaign that sought to maintain a cultural orientation whereby radical mastectomy would be perceived of as a "normal" practice. Meanwhile, traumatized women in the United States continue to be psychologically counseled to help repair their damaged, postoperative self-images. Such damage to identities could be defined as medical error by both sociologists and the women affected, although doctors and the courts might disagree.

The British working-class students who are the focus of Paul Willis's book, *Learning to Labor,* can be seen as defending their identity when they refuse to submit to standards of behavior that the middle-class school system seeks to impose on them.[7] In constructing their own identities according to such oppositional views, students are defined as creating "problems" and eventually become "dropouts."

As societies change, the former bases of identity construction give way to new bases. In France, Dubet discusses the members of the suburban youth gangs who no longer define themselves in relation to the values of industrial society. The gang members could be hypothesized to have cultural orientations toward education that differ from those of their counterparts who remain attached to traditional working-class values.[8]

But it is important to underline that transformations are also observed in definitions of doctors' or teachers' roles or in their actions.[9] The social location of such changes becomes an important element of sociological analysis.

In the world of medicine patients resist medical domination when they speak of the right to a dignified death, refuse blood transfusions on religious grounds, or demand complete information about their own treatment. Corporate medicine, organ transplants, genetic engineering, and *in vitro* fertilizations modify medical culture, information, and interests. Such changes frequently undermine the traditional bases of the construction of professional identities, one of which is ethical, and are associated with the development of new tensions.

Current questioning of traditional and emerging approaches to industrial safety was linked to the transition toward a postindustrial society. If once again we evoke the idea that accidents are a metaphor, it can be hypothesized that the rise of a new culture, the modification of notions of information and of interest that are associated with it, and the

chipping away of the foundations of the old are specific bases in which an increased questioning of the rationalization of the educational and health systems are grounded.

Toward a Sociology of Medical Error and School Failure

Structural and case studies allow us to see that in both the classroom and the hospital relationships to health and education are managed through social relations. Some of these have a more than superficial similarity with social relations to be found in industry and are implicated in error production. Thus, at the command level, the authoritarianism of doctors toward patients and staff impedes information flow in hospitals, the presence of temporary staff and irregular shift rosters leads to disintegrated workgroups in the ward, and new technologies are frequently perceived by nursing staff as increasing dangers to patients yet constant technical change is passively accepted as a normal element of medical work. At the rewards level, students' learning capacities may be reduced because of malnutrition. In 1952, Howard Becker highlighted that inattention to cultural differences of pupils by middle-class teachers produced inequalities in the school, and excessive pressure to succeed may lead students to burnout. At the organizational level, underqualification of teachers is combated through formal training, disorganization in hospitals leads to rigid job definitions and responsibilities, and the routine of the classroom is fought by appeals to variety.[10]

In spite of apparent similarities, a theory of medical error or educational failure cannot be seen as a direct translation of a theory of accidents. Three examples can serve as illustrations: first, the basis for constructing clear definitions of error that are intersubjectively agreed upon, as was alluded to in the case of radical mastectomy and can be seen in Parker's controversial analysis of "overeducation" as a structural failure of the Ecuadorian university system,[11] appear considerably less "obvious" than accidents and far more elusive. Second, industrial workplaces do not customarily have actors with the equivalent status of a five-year-old child or a patient in a coma, which makes the conceptualization of social relations in hospitals and schools a complex matter. Finally, the content of levels of social relations may differ; for example, schools define at least some teachers' rewards with relation to a cash nexus but do not do so for pupils. Such observations suggest that considerable challenges await those who might wish to build theories of error production in new domains.[12]

TOWARD A SOCIOLOGICAL SCHOOL: READJUSTING THE PRISM

It is significant that in introducing *Crisis in the Classroom,* Silberman traced his point of departure back to Rousseau's *Émile.* He quotes: "People are always telling me to make PRACTICAL suggestions. You might as well tell me to suggest improvements which may be incorporated with the wrong methods at present in use." In a familiar tone Silberman observes that "everything now being done needs to be questioned."[13]

In both education and health, global questions, of an order similar to those framed with regard to accidents in the last two decades, have been raised. Here I will limit myself to a few observations. From the radical system level critiques of Ivan Illich to the practical "ways out" provided by Freire, Papert,[14] and feminist medicine, new ideas and interdisciplinary insights emerge. Simultaneously, the imperative to reject many old structures, interventions, and practices is evoked. Frequently, by making reference to notions of identity, calls are made for the empowerment of dominated actors. Appeals are made for political struggle against the interests, expressed through the institutions, that define the criteria of and dominate the production of education and health. Information, and access to it, are henceforth to be produced and provided in new manners.

A vast range of social experiments are performed and discussed: alternative schools, education vouchers, and parallel medicines are just some of them. Among these, approaches can be found that are based in the most antirational and traditional notions, rejecting, as it were, modernity itself. Other approaches, while contesting overrationalized elements of dominant models of health and education, act to preserve notions of rationality and progress embedded within them. It can be hypothesized that profound transformations in notions of interest, of information, and within the cultural sphere underlie many of these experiments and debates.

CONCLUSION

Advanced Western societies appear fragile as the capacities of organizations that were once seen as marks and powerhouses of modernization are subject to increasing questioning: industry, health, education, social welfare, science, the professions. The image of a modernization

process grounded in rationalization that would bring progress, triumphant for such a large part of this century, gives way to an image whereby key components of this process are rejected or depicted as being in a state of permanent crisis.

Is not one of the tasks confronting sociology the recreation of our images of phenomena such as waste, failure, and scientific fraud, and through this to permit social actors to become conscious of the limitations of practices exercized in the name of rationalization and modernization? In producing such an image will not a picture be created of actors who represent different logics, of forces that are already producing another society, its cultural representations, its power and conceptions of interest, its capacities to produce and manage information about itself? Cannot sociologically grounded discussion, through the analysis of such processes, characterize emergent struggles and social practices, and thereby contribute to building a capacity for social actors to draw maps that permit them to perceive and eventually transform society's impasses?

Today many talk of the decline of the "modern" condition; what is often suggested is that it be replaced by institutions reformed or constructed on the mounds left in its wake. By examining in-depth one element of the modern condition—industrial accidents—and by suggesting, especially in this afterword, that the phenomenon may be perceived as a metaphor for other types of socially produced error, it has been my hope to provide a new prism through which to perceive and analyze the future of contemporary societies.

NOTES

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2. A. W. Gouldner, 1959. Organizational analysis, in R. K. Merton, L. Broom, and L. S. Cottrell (eds.). 1959. *Sociology Today,* pp. 400–428. New York: Basic Books. I. Berg. 1986. Deregulating the economy and reforming workers: The eclipse of industrial democracy, in R. Mulvihill (ed.). 1986. *Reflections on America, 1984: An Orwell Symposium,* pp. 136–158. Athens: University of Georgia Press. A. Touraine. 1988. Modernity and cultural specificities. *International Social Science Journal* 40(118):443–457.
3. Z. Brandao, A. M. B. Baeta, and A. D. C. da Rocha. 1983. O estado da arte da pesquisa sobre evasao e repetencia no ensino de 1° grau no Brasil. *Revista Brasileira de Estudos Pedagogicos* 64(147):38–69 (p. 61).
4. R. Girod. 1981. *Politiques d'Éducation.* Paris: Presses Universitaires de France, cited in A. Touraine. 1988. *The Return of the Actor,* p. 72. Minneapolis: University of Minnesota Press.
5. S. Y. Fagerhaugh, A. Strauss, B. Suczek, and C. L. Wiener. 1987. *Ensuring Patient Safety.* San Francisco: Jossey-Bass, discuss this concept.

6. L. Payer. 1988. *Medicine and Culture*. New York: Holt.
7. P. Willis. 1981. *Learning to Labor*. New York: Columbia University Press.
8. F. Dubet. 1987. Conduites marginales des jeunes et classes sociales. *Revue Française de Sociologie* 28:265–286.
9. L. Demailly. 1987. La qualification ou la competence professionnelle des enseignants. *Sociologie du Travail* 1:59–69. L. R. Tancredi and J. A. Barondess. 1978. The problem of defensive medicine. *Science* 200(May 26):879–882.
10. A variety of studies provide data and insights that permit these and other sociological insights to be drawn, for example: Fagerhaugh *et al.*, 1988; Brandao *et al.*, 1983; H. Becker. 1952. Social class variations in the teacher-pupil relationship, in H. Becker. 1970. *Sociological Work: Method and Substance*. New Brunswick, NJ: Transaction Books; M. Millman. 1977. *The Unkindest Cut: Life in the Backrooms of Medicine*. New York: William Morrow; C. L. Bosk. 1979. *Forgive and Remember: Managing Medical Failure*. Chicago: University of Chicago Press; and S. Joel. 1978. *Medicine and the Reign of Technology*. Cambridge: Cambridge University Press. In a less sociological vein: F. Robin and F. Nativi. 1987. *Enquête sur l'Erreur Médicale*. Paris: Maspero. For an attempt to build a radical critique of education that contains many insights into the social production of error see: S. Aronowitz and H. Giroux. 1985. *Education under Siege*. Westport, CT: Bergin and Garvey.
11. E. Parker. 1989. L'éducation peut causer des catastrophes. *Futuribles* 131(April):17–28.
12. Once formulated, a theory of error can be tested. Research by Dubet *et al.* and Barley was mentioned in Chapter 4 as seeking to provide controlled observations of interventions in hospitals and schools. As such, these provide potential models for studies that might seek to test specific hypotheses drawn from a theory.
13. C. E. Silberman. 1970. *Crisis in the Classroom*, p. 4. New York: Random House.
14. I. Illich. 1970. *Deschooling Society*. New York: Harper & Row. I. Illich. 1977. *Medical Nemesis*. New York: Bantam. P. Freire. 1973. *Pedagogy of the Oppressed*. New York: Seabury. S. Papert. 1980. *Mind Storms*. New York: Basic Books.

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